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Flora of Karabakh, plant cover and main directions of plant resources research

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The article provides information on the main directions of the study of flora, plant cover, and plant resources in the Karabakh region, based on the monitoring, analysis of herbarium and seed materials and analysis of published monographs, books, and scientific articles during the author's expeditions to the Karabakh region in pre-occupation years. According to these, priority areas of research to be conducted in the liberated territories are indicated. These works included the launch of a new edition of the multi-volume "Azerbaijan Flora" and at the same time the monographs "Flora of Karabakh", "Karabakh plant cover" and "Plant Resources of Karabakh", and developing the "Red Book of Karabakh". These studies are important in restoring the biodiversity of Karabakh. Protection and restoration works, which were planned to be carried out before the occupation, but due to the occupation factor was not completed are needed.

Keywords: *Karabakh, flora, plant growing, plant resources, Red Book, restoration, protection*

INTRODUCTION

As a result of the 44-day Patriotic War started on September 27, 2020, in the Republic of Azerbaijan, our lands in the territory of Karabakh and surrounding regions were liberated from occupation.

The Karabakh region is one of the most important regions not only in Azerbaijan, but also in the whole Caucasus, with its ancient history, unique material and cultural heritage, unique flora and fauna, rich underground and surface resources. It is no coincidence that the Azykh cave complex, one of the oldest human settlements in the world, is also located in Karabakh.

In these territories, which have been under enemy occupation for nearly thirty years, the flora, vegetation, and plant resources, an important component of biodiversity, as well as other resources of the region, especially valuable forests have been deliberately destroyed. Our valuable oak, beech, hornbeam and linden forests were cut down and looted in Kalbajar, Agdara, and Lachin districts. Armenians have increased their wood processing 4-5 times due to felled trees in Azerbaijan. In 1988, the forest fund in the liberated areas was 228,000 hectares, and in 2020 it was only 174,000 hectares, i.e. 54,000 hectares of forest fund was destroyed.

MATERIALS AND METHODS

Information on the flora, plant cover and plant resources of the territory was based on monitoring data conducted during numerous floristic expeditions to Karabakh under the authority of the author in the pre-occupation years, analysis of collected herbarium and seed materials and published data of obtained results (Asgarov, 2005, 2006, 2008, 2011, 2016, 2019; Asgarov et al., 2016). Furthermore, the materials of the Herbarium Foundation of the Institute of Botany of ANAS were studied in the Herbarium Fund of Botanical Institute of the Russian Academy of Sciences. The books and monographs published on this topic were used (Flora of Azerbaijan, 1950-1961; Prilipko, 1970; Hajiyev et al., 1990).

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Fig. 1. Physical and geographical regions of Karabakh

The botanical-geographical zoning of Karabakh is very important for the study of the biodiversity of the territory. According to the zoning scheme adopted in the multi-volume "Flora of Azerbaijan", botanists frequently consider 2 regions ("Center of the Lesser Caucasus" and "South of the Lesser Caucasus") as the whole borders of Karabakh. We see Karabakh in a broader sense, within physiographic districts: from the north-the Murovdagh range, territory of Tartar River joining the Kura River; From the east - the right bank of the Kura; From the south - the territory along the Araz; From the west, the state border of our Republic with Armenia. Comprehensive botanical-geographical zoning of Karabakh will be possible only after the completion of the study of the flora and plant growth of the territory, especially the investigation of endemism.

RESULTS AND DISCUSSION

The main directions of post-occupation research to be conducted in the Karabakh region are as follows.

I. Launch of a new edition of the multi-volume "Flora of Azerbaijan", design of "Karabakh flora". The implementation of this work is very important in a comprehensive study of the biodiversity of Karabakh. According to our current research, more than 2,500 higher plant species, found in the liberated territory of Karabakh account for 50% of the flora of Azerbaijan. We can now obtain information about the flora of Karabakh from the 8-volume "Flora of Azerbaijan" (Flora of Azerbaijan, 1950-1961) written in Russian 70 years ago, the unreleased "Trees and shrubs of Azerbaijan" (vol.I, 1961; vol.II, 1964; vol.III, 1970), as well as research on "The plant world of Azerbaijan" (Asgarov, 2016), "Cereals of Azerbaijan" (Musaev, 1991) and from researches conducted on some species.

II. Monograph of Karabakh vegetation and compilation of large-scale vegetation map. No special studies has been conducted on the vegetation of Karabakh. Fragmentary information can be obtained from the works of L. Prilipko" The plant world of Azerbaijan" (Prilipko, 1970), V. Hajiyev and others "Flora and plant growing of Lesser Caucasus" (Hajiyev et al.,1990). In Karabakh, the main vegetation types of Azerbaijan, especially forest, steppe, alpine and subalpine, rock vegetation are widely represented.

III. The plant resources of Karabakh also require detailed research. The State Program on Karabakh envisages the creation of "Atlas of natural resources of Karabakh". However, for this purpose must be conducted. biosystematic research first. At present, under our authority, research is being conducted on "Plant genetic resources of Karabakh." According to preliminary research, plant genetic resources in Karabakh belong to 14 gene pool groups (wild edible weeds; wild vegetable plants; fruits and berries; spices; cereals; grain legumes; legumes; fodder plants; medicinal herbs; essential medicinal plants; technical plants; vitamin plants; melliferous herbs; tinctorial plants) 664 genera, 1110 species. In many cases, the same species are represented in several gene pool groups. In the next years, the identification of their habitats, bioecological characteristics, reserves, protection and use opportunities will be studied.

More than 4,500 species of higher plants in the country are a source of natural raw materials with beneficial properties for our economy. Their study is very important from both the science and economic point of view (Vinokurov V. I., 2018).

As a result of the preliminary research conducted based on literary, herbarium-fund and internet resources, the classification of plant genetic resources distributed in the Karabakh region was carried out and a basic systematic syllabus was developed.

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Table 1. Useful plant groups in the liberated areas

№	Useful plant groups	Families	Genera	Species
1.	Wild edible weeds	13	29	67
2.	Wild vegetable plants	39	97	124
3.	Fruits and berries	14	29	102
4.	Spices	24	59	91
5.	Grain legumes	1	9	20
6.	Cereals legumes	1	3	17
7.	Legumes	1	7	21
8.	Fodder plants	2	13	47
9.	Medicinal herbs	66	161	198
10.	Essential medicinal plants	15	37	66
11.	Technical plants	36	59	82
12.	Vitamin plants	9	51	107
13.	Melliferous herbs	31	82	138
14.	Tinctorial plants	23	28	30

Edible weeds are represented by 13 families, 29 genera and 67 species. The plants of great importance for human health as onion (*Allium* L.), nettle (*Urtica* L.), knotweed (*Polygonum* L.), sorrel (*Rumex* L.), ferula (*Prangos* Lindl.), caseweed (*Capsella* Medik.), amaranth (weed) (*Amaranthus* L.), sickleweed (*Falcaria* Fabr.), etc. belong to this group.

Wild vegetable plants are represented by 39 families, 97 genera and 124 species. Among the wild vegetable plants desert candle (*Eremurus* Bieb.), dropwort (*Asparagus* L.), nettle (*Urtica* L.), knotweed (*Polygonum* L.), goosefoot (*Chenopodium* L.), amaranth (weed) (*Amaranthus* L.), portucaceaea (*Portulaca* L.), purslane (*Bunias* L.), ground cherry (*Physalis* L.), and ferula (*Prangos* Lindl.) are valuable raw materials. Many of these are valuable vegetables, cereal, starchy plants with protein and sugar features, odorous, pleasant taste. Wild vegetable plants contain aqueous carbohydrates, proteins, fats, vitamins, alkaline mineral salts, organic acids, aromatic and specific flavors. In the human diet, their use regulates the activity of the nervous system, increases appetite, resistance to infectious diseases, and the ability to work increases when taken regularly. Most wild vegetables are resistant to cold (Gasimov et al., 2004).

14 families, 29 genera and 102 species of important food and nutrition plants belonging to the Karabakh region were determined. These plants include hazelnuts (*Corylus* L.), medlar (*Mespilus* L.), quince (*Cydonia* Mill.), fig (*Ficus* L.), apple (*Malus* Hill), pear (*Pyrus* L.), dog-rose (*Rosa* L.), sumac (*Rhus* L.), blackberries (*Rubus* L.) etc. The composition of these plants is rich in vitamins, microelements, pectin, proteins, carotenoids, fiber and other biologically active substances important for the human body (Gasimov et al., 2004).

Abstracts of 24 families, 59 genera and 91 species of spice plants belonging to the research territory were made. 14 species of them are trees and shrubs. These include onion (*Allium* L.), sorrel (*Rumex* L.), barberry (*Berberes* L.), sumac (*Rhus* L.), fennel (*Foeniculum* Hill), mint (*Mentha* L.), thyme (*Thymus* L.) etc. plants. The composition of these plants contains vitamins, microelements, proteins, fats, carbohydrates, sugars, organic acids, etc. important for the human body. Aromatic compounds in spice raw materials consist of very complex components. Aromatic substances accumulate in the leaves, roots and rootstock, stems and peel of the plant. In rare cases, it accumulates in flowers and seeds. The bitter substances in spices are very important. Thus, they improve digestion by increasing gastric juice.

20 most promising species of 9 genera belonging to *Gramineae* family were studied. These species are annual and perennial grasses. These are of food and forage significance. The most widespread species of wheat (*Triticum* L.), rye (*Hordeum* L.), millet (*Panicum* L.), barley (*Hordeum* L.), goat grass (*Aegilops* L.), palmgrass (*Setaria* Beauv.) also cover the Aran Karabakh region.

Cereal legumes include 17 promising species belonging to 3 genera of the legume family. These are annual and perennial herbs. They are high-protein crops and are used as food and forage. Lentil (*Lens* Mill.) and wild pea (*Pisum* L.), as well as high-forage varieties of vetch (*Vicia* L.) are more common in Aran Karabakh territories.

The group of leguminous forage plants includes 30 species belonging to 9 genera of the legume family. They are annual and perennial herbs. These are the most important forage plants (*Astragalus* L., *Lotus* L., *Trigonella* L., *Dorycnium* Mill., *Lagonychium* Bieb.), medicinal herbs (*Glycyrrhiza glabra* L., *Melilotus officinalis* (L.) Pall.) and mostly spread in the mountainous part of Karabakh.

Fodder grasses include (1 genus, 2 species) important promising representatives of the *Leg-*

umes and *Gramieae* families (12 genera, 45 species). They are most widespread in the mountainous part of Karabakh. The most common species are the genus wheat-grass (*Elytrigia* Desf.), fescue (*Festuca* L.), rye-grass (*Lolium* L.), meadow-grass (*Poa* L.) and timothy (*Phleum* L.).

The most promising medicinal plants are represented by 66 families, 161 genera and 198 species. According to N. Mehdiyeva (Mehdiyeva, 2021), who studied medicinal plants in Azerbaijan, 606 species of medicinal plants belonging to 110 families and 397 genera (11 of them are lichens) are widespread in Karabakh and 66 species of them are used as medicine in official medicine.

The most widespread medicinal plants in the Karabakh region are medicinal dandelion (*Taraxacum officinale* Wigg.), common butter-bur (*Tussilago farfara* L.), medicinal fern (*Nasturtium officinale* R. Br.), field horse-tail (*Equiesetum arvense* L.), sclerophyllus (*Heracleum pastinacifolium* C.Koch), marshmallow (*Althaea* L.), nipplewort (*Chelidonium* L.), fumitory (*Fumaria* L.), and others. Many of these plants play an important role in the development of new medicines.

There are 66 species of oilseeds and essential oil plants of 15 families and 37 genera in the Karabakh region. This group includes water mint (*Mentha aquatica* L.), common caraway (*Carum carvi* L.), common fennel (*Foeniculum vulgare* Mill.), odorous celery (*Apium graveolens* L.), common wormwood (*Artemisia vulgaris* L.), medicinal balm (*Melilotus officinalis* L.), catnip (*Nepeta* L.), elecampane tall (*Inula helenium* L.) etc.

In this region, technical plants are represented by 36 families and 82 species of 59 genera. These include Georgian oak (*Quercus iberica* Stev), quinquelocular hawthorn (*Crataegus pentagyna* Waldst.et Kit. (incl. *C.atrofusca* Stev.ex Fisch.et Mey.), sumac (*Rhus* L.), broadleaved linden (*Tilia platyphyllos* Scop. (*T.prilipkoana* Grossh. et J.Wagner, *T. begoniifolia* Stev)), common wayfarling-tree (*Viburna opulus* L.), Caucasus groundsel (*Senecio caucasicus* (Bieb.) DC. (*Dolichorrhiza caucasica* (Bieb.) Galushko)), oblong juniper (*Juniperus oblonga* M.Bieb.), flattened meadow-grass (*Poa compressa* L.), common carline (*Carlina vulgaris* L.).

According to the group of vitamin-containing plants, there are 9 families, 51 genera, 107 species of trees, shrubs and grasses. These plants are rich in vitamins A, D, E, C and B. The most common fruit plants are cotoneaster (*Cotoneaster* Medic.), pear (*Pyrus* L.), service tree (*Sorbus* L.), medlar (*Mespilus* L.), hawthorn (*Crataegus* L.), blackberry (*Rubus* L.), strawberry (*Fragaria* L.), dog-rose (*Rosa* L.), plum (*Prunus* Mill.), cour cherry (*Cerasus* Juss.), from legume plants -clover (*Trifolium* L.), pea (*Lathyrus* L.), vetch (*Vicia* L.), from cereal plants - barley (*Hordeum* L.), fescue (*Festuca* L.), meadow-grass (*Poa* L.) and others. These plants are mainly distributed in the mountainous part of Karabakh.

İt has been specified that in the Karabakh region 138 species of melliferous plants in 31 families and 82 genera were distributed. 29 species of these are distributed in the mountainous part of Karabakh, 20 species in Aran Karabakh. Other species are found in both territories of Karabakh. Primary melliferous plants include Bieberstein's rock currant (*Ribes biebersteinii* Berl. ex DC), western apple (*Malus orientalis* Uglitzk.), scabrous everlasting pea (*Lathyrus hirsitus* L.), common germander (*Teucrium chamaedrys* L.), hawthorn (*Crataegus* L.).

The majority of crops, which make up 15-17% of the wild plants found in the flora of Azerbaijan, are melliferous plants. Shrubs and broad-leaved forests are of great importance for beekeeping.

The distribution of 30 species of tinctorial plants in 23 families and 28 genera in the Karabakh region has been specified. Common privet (*Ligustrum vulgare* L.), common marjoram (*Origanum vulgare* L.), hazelnut (*Juglans* L.), Saint-Johns wort (*Hypericum perforatum* L.), common barberry (*Berberes vulgaris* L. (*B. orientalis* C. K. Schneid.), etc. widely used for the paint industry.

Tinctorial plants are plants used to dye wool, silk and cotton products by preparing a dye extracted from parts of roots, stems, branches, rootstock, leaves, flowers, fruits or seeds.

According to M.Gasimov (Gasimov, 1980), tinctorial plants found in our republic assosiated in 110 families and 358 genera and are 36% of our total flora.

IV. Study of rare and endangered plant species of Karabakh, making of "Red" and "Green" books. The main factor that makes these studies relevant is the fact that the flora of this territory has been under Armenian occupation for almost 30 years.

Most of the 400 rare and endangered plants included in the 1st (1989) and 2nd (2013) editions of the Red Book of Azerbaijan are found in Karabakh: orchis (*Ophrys* L.), common yew (*Taxus* L.), germander (*Teucrium* L.), some species of Sternbergia (*Sternbergia* Waldst. et Kit.), Yurineya (*Jurinea* Cass.) etc. known under the names Shusha milk vetch (*Astragalus schuschensis* Grossh.), Garabagh tulip (*Tulipa karabachensis* Grossh. (*T. confuse* Gabr.)), Shusha sainfoin (*Onobrychis schuschajensis* Agaeva), Khari bulbul (*Ophrys caucasica* Woronow ex Grossh.). During the past period, no practical measures were taken to save our natural monuments, rare and endangered flora and fauna. During the pre-occupation period, in these territories, we recorded 264 rare higher plant species belonging to 65 families and 171 genera. There were 21 species of endemics belonging to 12 families, 17 genera, 34 families, 84 genera, 119 subendemics, 51 families, 99 genera, 169 species of rare and endangered plants, about 54 species of rare trees and shrubs (Asgarov et al., 2017).

Forest Restoration based on world experience is one of the most important issues. The study of specially protected natural areas (reserves, reservations, etc.), their expansion and the creation of new ones require extensive research. This work is also envisaged in the State Program on Karabakh.

The liberated lands also have state nature reserves and preserves. Two state nature reserves with a total area of 43,000 hectares, four state nature preserves, 152 natural monuments - ancient trees were looted.

One of them - Basitchay State Nature Reserve in Zangilan district was established in 1974 on the initiative of great leader Heydar Aliyev. It is considered a unique forest in Europe, and there were rare plane trees. This reserve covered an area of 107 hectares along the river for 15 km (width 150-200 m) during the pre-occupation period, and now there are only 42 hectares left.

Specially Protected Natural Areas in Gubadli, Shusha and Lachin districts have also been almost destroyed.

In the forests along the Tartar River, in a territory of 50 km were recorded walnut trees. Here, at an altitude of 700 m above sea level, new natural areas of ordinary chestnut trees were found.

Holly, yew, beech and hornbean forests, which are considered to be relict plants of the third period, were also found in Karabakh. These unique relict forest areas were the only ones in the Lesser Caucasus (within Azerbaijan).

We propose to clarify and protect these areas, found by our research scientists during the pre- occupation period, as a preserve.

Organization of the work on ethnobotanical research of Karabakh, organization of documentaries, radio and television programs on the nature of Karabakh, preparation of brochures and booklets, implementation of large-scale scientific and mass events are considered to be very important.

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Qarabağın florası, bitki örtüyü və bitki ehtiyatlarının tədqiqinin əsas istiqamətləri

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Məqalədə müəllifin Qarabağ bölgəsinə, əsasən işğaldan əvvəl təşkil etdiyi ekspedisiyalar zamanı apardığı monitorinqlər, topladığı herbari və toxum materiallarının təhlili və nəşr olunmuş monoqrafiya, kitab və elmi məqalələrin təhlili əsasında regionun florası, bitki örtüyü və bitki ehtiyatlarının tədqiqinin əsas istiqamətləri haqqında məlumat verilir. Bu istiqamətlər üzrə işğaldan azad edilmiş ərazilərdə aparılacaq tədqiqat işlərinin prioritet sahələri göstərilir. Bu işlərdən "Azərbaycan florası" çoxcildliyinin yeni nəşrinə başlanılması və bununla paralel "Qarabağın florası", "Qarabağın bitki örtüyü" və "Qarabağın bitki ehtiyatları" monoqrafiyalarının yazılması, "Qarabağın Qırmızı kitabı"nın işlənib hazırlanması qeyd edilir. Bu tədqiqatların bütövlükdə Qarabağın biomüxtəlifliyinin bərpa olunmasındakı mühüm əhəmiyyəti əsaslandırılır. İşgaldan əvvəl həyata keçirilməsi nəzərdə tutulan, lakin işğal faktoru ilə əlaqədar yarımçıq qalmış mühafizə və bərpa işlərinin təcili olaraq həyata keçirilməsinin zəruriliyi qeyd olunur.

Açar sözlər: *Qarabağ, flora, bitkilik, bitki ehtiyatları, Qırmızı kitab, bərpa, mühafizə*

Основные направления исследования флоры, растительности и растительных ресурсов Карабаха

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В статье приводятся данные об основных направлениях исследования по изучению флоры, растительности и растительных ресурсов Карабахского региона. Эти данные были получены автором в результате проведенных им мониторингов, анализов гербарных материалов и семян, собранных во время флористических экспедиций по Карабаху. Были использованы также важнейшие публикации по теме. Одновременно приводятся приоритетные работы, которые необходимо реализовать на освобожденных от оккупации землях. Основные из них следующие: начало работы по переизданию многотомного издания (многотомника) «Флора Азербайджана» на азербайджанском языке; составление монографических работ: «Флора Карабаха», «Растительный покров Карабаха», «Растительные ресурсы Карабаха», «Красная книга Карабаха». Далее в статье обосновывается большая роль этих работ в изучении биоразнообразия Карабаха. В статье отмечается необходимость выполнения ряда незаконченных работ по охране и восстановлению растительного покрова Карабаха в связи с оккупацией этих территорий Вооруженными силами Армении.

Ключевые слова: *Карабах, флора, растительность, растительные ресурсы, Красная книга, охрана*

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On the preparation of the III edition of the "Red Book" of the Republic of Azerbaijan: Red List of Karabakh fauna

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The article has been developed relying on the results of research conducted by the staff of the Institute of Zoology of ANAS before the occupation of Karabakh and surrounding areas by Armenia. According to previous years' research in Karabakh and surrounding areas, which have been under occupation for nearly 30 years, 56 species of insect fauna are rare, endemic and endangered. Of the 53 fish species registered in the Lesser Caucasus of Azerbaijan, 7 are included in the Red Book of Azerbaijan (2013), and 4 species are included in the IUSN Red List. It was determined that 12 species of fish are distributed in the Hakari River, and 13 species in the Basitchay and Okhchuchay rivers. In the Lesser Caucasus natural region, 4 out of 11 species of amphibians belonging to the batrakhofauna of Azerbaijan and 35 out of 63 species of reptiles belonging to the herpetofauna are registered. 1 species of tortoises, 10 species of lizards and 13 species of snakes are distributed in the fauna of Karabakh. One species of amphibians and 7 species of reptiles were included in IUCN and GK (2013). Prior to the occupation, 32 species out of about 200 bird species registered in 16 orders and 57 families in Karabakh and its environs were included in the II Edition of the Red Book (2013). Most of these species are included in the lists of international conventions (Bern, Bonn, CITES, AEWA). Prior to the occupation of Karabakh, 24 species out of 75 species of mammals belonging to 6 orders were included in the Red Book of Azerbaijan (2013). Five of them are also included in the Red List of the International Union for Conservation of Nature (IUSN). The second edition of the Red Book of Azerbaijan, published in 2013, included 223 species of animals that are rare, endangered and in need of protection. Of these, 1 species belongs to the class *Oligochaeta*, 1 species *Crustacea*, 1 species *Mollusca*, 77 species *Insecta*, 9 species P*isces*, 6 species *Amphibia*, 14 species *Reptilia*, 72 species Aves, 42 species *Mammalia*. The third edition of the RB, which is scheduled for publication in 2023, will embrace 279 species of rare and endangered species. The issue of medical leech and 2 bony fish species proposed to be included in the 3rd edition of the Red Book of Azerbaijan will be clarified. It is proposed to remove 77 species of insects included in the second edition of the Red Book, 14 species in the third edition, and to increase the number of species on the updated list to 118 by adding 55 species. The list of amphibians (6 species) will not be changed, and the list of reptiles will include 6 additional species of reptiles. The third edition will consider the inclusion of 15 new species in the previous list, the second edition will consider the removal of 8 species of mammals from the list of mammal species and the inclusion of 1 species in the updated list of mammals.

Keywords: *Fauna, invertebrate, vertebrate, Red Book, amphibian, reptile, fish, mammal, IUSN, order, family*

INTRODUCTION

The Republic of Azerbaijan, which occupies one of the unique places in the world for its biological diversity, is the country with the richest natural resources in the Caucasus region. In recent years, as a result of anthropogenic factors threatening biodiversity and ecosystems around the world, ecosystems have been degraded, and many animal species and breeds have become extinct or threatened

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with extinction. According to the International Union for Conservation of Nature (IUSN), one species of animal disappears from our planet every day. 1000 species of birds and mammals are in danger of extinction, one in four amphibians and one in seven reptiles are in danger of extinction (Fauna of Azerbaijan, Volume III). Such cases have not escaped the fauna of Azerbaijan. In particular, there is no information on the current state of fauna in Karabakh and surrounding areas, which have been under occupation for nearly 30 years.

The Turanian tiger, once was common in the wild nature in Azerbaijan, has become extinct, and the Talysh pheasant (*Ph.c. talischensis*) is on the verge of extinction. There are no reports of the Pallas' cat (*Otocolobus manul*) or striped hyaena (*Hyaena hyaena*) in our fauna in the last 20 years. Such a state of biodiversity requires serious measures for its conservation and sustainable use. Very important work has been done in Azerbaijan to protect wildlife. The adoption of laws in this direction, the publication of the Red Book, the beginning of work on the preparation of the third edition, the creation of reserves, sanctuaries, national parks in various landscapes is the chain of such work.

The National Strategy and Action Plan for the Protection and Sustainable Use of Biological Diversity was approved and successfully implemented in our country by the Decree of the President of the Republic of Azerbaijan dated March 24, 2006, on the conservation and sustainable use of biological diversity.

In the Lesser Caucasus, the charming nest of Azerbaijan, which has been subjected to environmental terror by Armenia for nearly 30 years, has a very rich invertebrate and vertebrate world, with Karabakh and its surrounding regions sharply different from other regions of Azerbaijan in terms of natural conditions and vegetation. The fate of rare and endangered species, inhabiting the landscapes and biotopes of Karabakh and the liberated territories of the Lesser Caucasus is of greater concern.

Although specialists of the Institute of Zoology of ANAS conduct regular and intensive monitoring of fauna species in Azerbaijan, no monitoring has been conducted in occupied Karabakh and surrounding areas for about 30 years, and there is no information about the fauna of this region. During this period, as a result of environmental terror committed by Armenia, animal habitats were destroyed, populations were destroyed, caves, where they took refuge, were turned into weapons depots, and large animals were injured by landmines in mined areas. Due to the occupation of a large area of the Lesser Caucasus, the fauna of this unique region, home to many rare and economically important species, has gone unchecked. Contrary to international law and aimed at protecting the environment and wildlife, Armenia has had a devastating effect on the environment and nature. Undoubtedly, the savage treatment of nature has led to the loss of habitat and a decrease in the number of species that are susceptible to adverse effects.

MATERIALS AND METHODS

The results of research conducted by the staff of the Institute of Zoology of ANAS before the occupation of Karabakh and surrounding regions by Armenia have been utilized in writing the article.

RESULTS AND DISCUSSION

The charming nest of Azerbaijan occupied by Armenia, Karabakh and its surrounding regions have always been distinguished by the richness of its fauna diversity, differing sharply from other regions of Azerbaijan by its natural conditions. Until the beginning of the XX century, the fauna of Azerbaijan, including the Karabakh region, has always been in the focus of foreign researchers. Both Tsarist Russia and the Soviet Union conducted research in this area. In the late XIX and early XX centuries, K.Satunin, A.Vasilin, and P.Esben-Petersen conducted some research in all areas of Karabakh, including Horadiz, Shusha, Hadrud, and Fizuli districts.

At the beginning of the last century in the Lesser Caucasus, including Karabakh and surrounding areas, scientists of the Institute of Zoology of ANAS - I.Yevstropov, A.Bogachev, N.Yakovleva, Kh.Aliyev, R.Efendi, A.Abdinbayova, L.Rzayeva, S.Aliyev, N.Samadov, A.Aliyev, Z.Rasulova, N.Loginova and others conducted entomological studies.

Currently, over 10,000 species of insects, 63 species of reptiles, 11 species of amphibians, 104

species of fish and 115 species of mammals have been identified in our fauna as a result of the work of scientists working at the Institute of Zoology of the Azerbaijan National Academy of Sciences and other scientific research institutions and universities. Some of the species belonging to this fauna have the status of small and rare species. Arthropods make up 85% of all animal species found in Azerbaijan. Of the identified insect species, 370 were new species for science, 800 for the CIS countries, and more than 1,700 for the South Caucasus and Caucasian fauna. Arthropods found in the Azerbaijani territories of the Lesser Caucasus accounted for about 20% of the total arthropods distributed in Azerbaijan. In general, 79 species of invertebrates are included in the second edition of the Red Book in Azerbaijan (2013), including 1 species of annular worms (Annelida), 1 species of mollusks (Mollusca), 74 species of arthropods (Arthropoda), 4 species of hymenoptera (Hymenoptera). Pre-occupation species in the Lesser Caucasus accounted for about 20% of the total arthropods in Azerbaijan. 56 species of insect fauna in the occupied territories are rare, endemic and endangered. From beneficial insects Braconids - Braconidae, chalcids - Chalcidoidea, ichnevmonids - Ichneumonidae and aphids - Apidae are widespread in Karabakh and its environs (Абдинбекова, 1969; Рзаева, 1971, 2002; Алиев, 1985, 1980, 1983, 1984). In the territories of Shusha, Kalbajar, Lachin, Aghdara, Fizuli, Aghdam, Zangilan regions occupied for about 30 years until the 80s of the XX century, 49 species belonging to 13 genus of the family Halictidae: 10 species (*Halictus vestitus* Lepeletier, 1841, *H.sexcinctus* (Fabricius, 1775), *H.patellatus* Morawitz, 1873, *H.tetrazonius* (Klug, 1817), *H.maculatus* Smith, 1848, *H.setulosus* Strand, 1909, *H.scardius* Bluthgen, 1936, *H.quadricinctus* (Fabricius, 1776), *H.resurgens* Nurse, 1903, *H.simplex* Blüthgen 1923) of the genus Halictus Latreille, 1804, 12 species (*Lasioglossum discum* (Smith, 1853), *L.fallax* Morawitz, 1874, *L.leucozonius* (Schrank, 1781), *L.laevigatum* (Kirby,1802), *L.lativentre* (Schenck, 1853), *L.tadschicum* (Blüthgen, 1929), *L.aegypticollum* Strand, 1909, *L.zonulum* (Smith, 1848), *L.xanthopus* (Kirby, 1802), *L.denticole* Morawitz, 1876, *L.alievi* Pesenko, 1986, *L.majus* (Nylander, 1852)) of the genus *Lasioglossum* Curtis, 1833, 7 species (*Evylaeus marginatus* Brulle, 1832**,** *E.minutissimus* (Kirby, 1802), *E.clypearis* (Schenck, 1853), *E.sexstrigatus* Schenck, 1868, *E.politus* (Schenck, 1853), *E.malachurus* (Kirby, 1802), *E.lucidulus* (Schenck. 1861)) of the genus Evylaeus Robertson, 1902, 3 species (*Seladonia smaragdulus* Vachal 1895, *Seladonia subauratus* (Rossi, 1792), *Seladonia varipes* Morawitz, 1876) of the genus *Seladonia* Robertson, 1918, 1 species (*Vestitohalictus radoskovskii* Vachal, 1902) of the genus *Vestitohalictus* Blüthgen, 1961, 6 species (*Sphecodes monilicornis* (Kirby,1802), *S.alternatus* Smith, 1853, *S.gibbus* Linnaeus, 1758, *S.punctipes* Thomson, 1870, *S.gracilior* Pérez 1903, *S.pellucidus* Smith, 1845*)* of the genus *Sphecodes* Latreille, 1804, 1 species (*Ceylalictus variegates* (Olivier, 1789)) of the genus *Ceylalictus* Strand, 1913, 1 species of (*Nomioides minutissimus* (Rossi, 1790)) the genus *Nomioides* Schenck, 1867, 5 species (*Nomia diversipes* Latreille, 1806, *N.unidentata* (Olivier, 1811), *N.squamata* (Morawitz 1895), *N.lutea* Warncke, 1976, *N.innesi* (Gribodo, 1894)) of the genus *Nomia* Laterille,1804, 1 species (*Halictoides dentiventris* Nylander, 1848) of the genus *Halictoides* Nylander 1848, 1 species (*Rhophitoides canus* (Eversmann, 1852)) of the genus *Rhophitoides* Schenck, 1861, 1 species (*Rophites foveolatus* Friese, 1900) of the genus *Rophites*, 1 species (*Systropha planidens* Giraud, 1861) of the genus *Systropha* Illiger 1806 (Hüseynzadə, 2021), 9 species (*Julodis andreae andreae* Olivier, 1790, *Capnodis cariosa cariosa* Pallas, 1776, *Perotis lugubris longicollis* Kraatz, 1880, *Sphenoptera mesopotamica* Marseul, 1865, *Sphenoptera tamarisci beckeri* Dohrn, 1866, *Sphenoptera tenax* Jakovlev, 1902, *Anthaxia hungarica sitta* Küster, 1852, *Coraebus rubi* Linnaeus, 1767, *Meliboeus robustus* Küster, 1852) of Jewel beetles – Buprestidae (Huseynova, 2021) 10 species of long-horned beetles – *Cerambycida*e_(Səmədov, 2010), 90 species of braconids – Braconidae (Абдинбекова, 1975), 60 species of butterflies – *Rhopalocera* (Snegovaya, Petrov, 2019), 6 species (*Cueta anomala* (Navás, 1915), *Creoleon plumbeus* (Olivier, 1811), *Palpares libelluloides* (Linnaeus, 1764), *Myrmecaelurus trigrammus* (Pallas, 1781), *Distoleon tetragrammicus* (Fabricius, 1798), *Myrmecaelurus solaris* (Krivokhatsky, 2002)) of Myrmeleontidae, 1 species (*Deleproctophylla variegata* (Klug, 1845)) *Ascalaphidae* and 1 species (*Nemoptera sinuata* Olivier,

1811) of *Neuropteridae* (Kərimova, Şahverdiyeva, 2021) have been recorded. In addition to agricultural pests, these species include rare and endangered species. 152 species of agricultural and fruit-forest pests belonging to the group of insects were noted (Самедов, Мирзоева, 1982). Among therare species, *Empusa fasciata* Brullé, 1832 belong-ing to empusids was recorded in Shusha in 1906, and *Nemoptera sinuata* Olivier, 1811 in Zangilan in 1978, and 9 rare butterfly species were recordedby Aliyev (Алиев, 1984). 56 species of insectfauna in the occupied territories are rare, endemic and endangered.

10 of the 28 species of pests registered by Samadov in Azerbaijan in the 60s and 80s of the XX century (*Cyphosoma tataricum* (Pallas, 1773), *Capnodis tenebrionis* (Linnaeus, 1758), *C.miliaris miliaris* (Klug, 1829), *C.cariosa* (Pallas, 1776), *Perotis lugubris longicollis* Kraatz, 1880, *Lamprodila bella* (Gory, 1840), *Eurythyrea quercus* (Herbst, 1780), *Anthaxia cichorii* (Olivier, 1790), *A.bicolor bicolor* Falderman, 1835, *A.tractata*, Abeille de Perrin, 1901) is reported to be found in the Karabakh region (Huseynova, 2021).

The longhorn beetles - *Rhaesus serricollis* (Motschulsky, 1838), *Rosalia alpina* (Linnaeus, 1758), Caucasian splashing snaileater - (Carabus (Procerus) scabrosus caucasicus Adams, 1817), pretty ground beetle - *Calosoma sycophanta* (Linnaeus, 1758), the leaf-eating insect - *Labidostomis montana*, the white-spotted andrena - *Andrena albopunctata* (Rossi, 1792), *Zygaena tamara* Christoph, 1889, *Anthocharis gryneri* (Linnaeus, 1758), *Colias thiosa*, *Colias caucasica* Staudinger, 1871, *Manduca atropos* (Linnaeus, 1758), *Cyrebia anachoreta* (Herrich-Schäffer, 1851), *Isochlora viridis* (Staudinger, 1882) *(Noctuidae)*, the marvelous moth - *Staurophora celsia*, the scarlet tiger moth - *Collimorpha dominula*, the garden tiger moth - *Arctia caja* (Linnaeus, 1758), are included in the Red Book of Azerbaijan (2013).

In the modern fauna of Azerbaijan, vertebrates are represented by 700 species (Azərbaycan Faunasının taksonomik spektri. Onurğalılar, 2020). In the Kura River (including Varvara, Mingachevir, Yenikend, Shamkir reservoirs) bordering the Lesser Caucasus and its right tributaries (Khramchay, Agstafachay, Hasansu, Tovuzchay, Zayamchay, Shamkirchay, Goshgarchay, Ganjachay, Kurekchay, Tartarchay, Khachin) and in its left tributaries (Arpachay, Nakhchivanchay, Alinjachay, Gilanchay, Okhchuchay, Hakarichay, Kondelanchay), in the surrounding lakes (Sarisu, Aghgol, Mehman and other small lakes and ditches), in Upper Karabakh and other canals for irrigation, in Tartarchay reservoir, 53 species and subspecies of fish in Alagol, Karagol and other small water basins have been sprawled out (*Caspiomyzon wagneri* (Kessler, 1870) - Caspian Lamprey, *Salmo fario* Linneus, 1758 - River Trout, *Salmo caspius* Kessler, 1877 - Caspian Trout, *Salmo ischchan* Kessler, 1877 - Sevan Trout, *Esox lucius* Linnaeus, 1758 - Northern Pike, *Leuciscus cephalus orientalis* Kamensky, 1901 - Chub, *Scardinius erythrophthalmus* (Linnaeus, 1758) - Common Rudd, *Aspius aspius taeniatus* (Eichwald, 1831) - Aral Asp, *Leucaspius delineatus* (Heckel, 1843) - Belica, *Tinca tinca* Linnaeus, 1758) - Tench, *Pseudorasbora parva* (Temminck et Schlegel, 1846) - Stone Moroko, *Chondrostoma cyri* Kessler, 1877 - Terek Nase, *Romanogobio persa* (Günther, 1899) - Kura Gudgeon, *Capoeta sevangi* De Filippi, 1865 - Sevan Khramulya, *Luciobarbus capito* (Güldenstädt, 1773) - Bulatmai Barbel, *Luciobarbus brachycephalus caspius* (Berg, 1914) - Caspian Barbell, *Luciobarbus lacerta cyri* De Filippi, 1865 - Kura Barbel, *Luciobarbus mursa* (Güldenstädt, 1773) - Mursa, *Chalcalburnus chalcoides* (Güldenstädt, 1772) - Kura Bleak, *Alburnus hohenackeri* Kessler, 1877 - Caucasian Bleak, *Alburnus filippi* (DeFilippi, 1844) - Kura Bleak, *Acanthalburnus microlepis* (DeFilippi, 1863) - Blackbrow Bleak, *Alburnoides bipunctatus eichwaldi* (DeFilippi, 1863) - Caucasian Bream, *Blicca bjoerkna transcaucasica* (Linnaeus, 1758) - Silver Bream, *Abramis brama orientalis* (Berg, 1949) - Freshwater Bream, *Abramis sapa bergi* (Belyaev, 1929)- White-eye Bream, *Vimba vimba persa* (Pallas, 1814) - Caspian Vimba, *Hemiculter leucisculus* (Basilewsky, 1855) – Sharpbelly, *Pelecus cultratus* (Linnaeus, 1758) – Sichel, *Rhodeus sericeus amarus* Bloch, 1782) - Amur Bitterling, *Cyprinus carpio* (Linnaeus, 1758) - Carp, *Carassius auratus gibelio* (Bloch, 1782) - Silver Prussian Carp, *Barbatula angorae* (Steindachner, 1897) - Angora Loach, *Barbatula brandti* (Kessler, 1877) - Kura Loach, *Cobitis taenia satunini* (Barach, 1941)- Spined Loach, *Sabanejewa aurata*(De Filippi, 1863) - Golden Spined Loach,*Sabanejewa caspia* (Eichwald, 1838) - Caspian

Spined loach, *Silurus glanis* (Linnaeus, 1758) - Wels Catfish, *Gambusia affinis* (Baird & Girard, 1853) - Western Mosquitofish, *Perca fluviatilis* Linnaeus, 1758 - European Perch, *Sander lucioperca* Linnaeus, 1758 – Zander, *Neoqobius (Ponticola) platyrostris constructor* (Nordmann, 1840) - Caucasian Goby, *Neoqobius pallasi* (Berg 1916) - Caspian Sand Goby, *Neoqobius (Ponticola) gorlap* (Iljin, 1949) - Caspian Bighead Goby, *Proterorhinus marmoratus* (Pallas, 1814) - Tubenose Goby) (Абдурахманов, 1966).

Karabakh and the liberated territories are rich in reservoirs (rivers, lakes, reservoirs, springs, etc.). For nearly 30 years, these reservoirs have been subjected to environmental terror. Environmental terror has also affected the fish fauna that has formed over the years. It should be noted that the ichthyofauna of these areas is very poorly studied. The ichthyofauna of the Hakari River, one of the largest rivers in the liberated territories, was studied by Abdurahmanov (Абдурахманов, 1966) in the 60s of the last century, and the ichthyofauna of Basitchay and Okhchuchay in the 70s by Mammadova and Nasirov (Мамедова, Насиров, 1975). The authors determined that 12 species of fish are distributed in the Hakari River, and 13 species of fish in the Basitchay and Oxchuchay rivers.

In studying the amphibian and reptile fauna of the occupied territories, Aliyev, Alakperov Jafarova, Ahmadov (Алиев, 1974, Алекперов, 1978, Джафарова, 1981, 1982; Алекперов, Джафарова, 1979, Ахмедов, 1981), and others had special merits.

Of the 11 species of amphibians belonging to the batrachafauna of Azerbaijan, and 35 of the 63 species of reptiles belonging to the herpetofauna, were registered in the Lesser Caucasus natural region (Джафарова, 1984, 2004).

In the territory of Karabakh, 1 from reptile fauna (*Testudo graeca* Linnaeus 1758), 10 lizards (*Trapelus ruderatus* (Olivier, 1804), *Paralaudakia caucasica* (Eichwald, 1831), *Phrynocephalus horvathi*, DeFilippi, 1863, *Trachylepis septemtaeniata* (Reuss, 1834), *Eumeces shneideri* (Daudin, 1802), *Eremias strauchi* Kessler, 1878, *E.pleskei* Nikolsky, 1905, *Psedopus apodus* (Pallas, 1775), *Ophisops elegans* énétries, 1832, *Lacerta strigata* Eichwald, 1831), 13 species of snakes (*Typhlops vermicularis* Merrem, 1820, *Eryx jaculus* (Linnaeus, 1758), *Platyceps najadum* (Eichwald 1831), *Dolichophis shmidti* (Nikolsky, 1909), *Hemerrhois ravergieri* (Menetries, 1832), *Eirenis collaris* (Menetries, 1832), *E.punctatolineata* (Boettger, 1892), *E.modestus* Martin, 1838, *Rhynchocalamus melanocephalus* (Jan, 1862), *Telescopus fallax* Fleischmann, 1831, *Psammophis lineolatus* (Brandt, 1838), *Malpolon monspessulanus* (Hermann, 1804), *Macrovipera lebetina obtusa* (Dwigubsky, 1832)) have been sprawled out (Cəfərova, Bünyatova, 2021).

Eurasian Marsh Frog - *Pelophylax ridibundus*, Levantine Viper - *Macrovipera lebetina optusa*) are considered to be economically viable species in these areas. One species of amphibians (*Hyla orientalis* - Oriental Tree Frog) found in the Lesser Caucasus and adjacent foothills of Azerbaijan has been included in the IUCN Red List, and 7 species of reptiles (*Testudo graeca* - Common Tortoise, *Trapelus ruderatus* - Horn-scaled Agama, *Ablepharus bivittatus* - Twin-striped Skink, *Elaphe sauromates* - Urartian Ratsnake, *Zamenis hohenackeri* - Transcaucasian Ratsnake, *Coronella austriaca* - Smooth Snake, *Montivipera raddei* Radde's Rock Viper) were included in the IUCN Red List and in the Red Book of Azerbaijan (2013). Common Tortoise - *Testudo graeca* is as an endangered, Rostombekov's Lizard - *Darevskia rostombekovi* has been included in the IUSN Red List with the status of a critically endangered species. The Mediterranean tortoise is also on the CITES International Trade in Prohibited Species (https://cites.org/eng/app/appendices.php).

Of the snakes, the South Transcaucasian Ratsnake - *Zamenis hohenackeri* (Strauch, 1873) and Urartian Ratsnake - *Elaphe sauromates* (Pallas, 1811) are endemic species of the Caucasus (İsgəndərov və b., 2021).

As a result of the latest inventory of our ornithofauna and inspection of collection materials, as well as critical processing of all scientific data, 407 species of birds belonging to 19 groups, 64 families, 209 genera were identified in the territory of Azerbaijan (Azərbaycan Faunasının taksonomik spektri. Onurğalılar, 2020). The bird fauna of the Lesser Caucasus was richer than that of other groups of animals. About 200 species of 367 species of birds belonging to 16 orders and 57 families existed in Azerbaijan before the occupation in this area (*Pernis apivorus* (Linnaeus, 1758) - European Honey-buzzard, *Milvus milvus* Linn., 1758 - Red Kite, *M.migrans* Bodd., 1783 - Black Kite, *Accipiter gentilis*

Linn., 1758 - Eurasian Goshawk, *Accipiter nisus* Linn., 1758 - Eurasian Sparrowhawk, *Buteo lagopus* Pont., 1763 - Rough-legged Buzzard, *B.buteo* Linn., 1758 - Common Buzzard, *Circaetus gallicus* Gmelin, 1788 - Short-toed Eagle, *Aquila heliaca* Savigny, 1809 - Asian Imperial Eagle, *A.chrysaetos* Linn., 1758 - Golden Eagle, *Falco cherrug* Gray, 1834 - Saker Falcon, *F.peregrinus* Tunst., 1771 - Peregrine Falcon, *F.biarmicus* Temm., 1825 - Lanner Falcon, *F.subbuteo* Linn., 1758 - Hobby Falcon, *F.naumanni* Fleischer, 1818 - Lesser Kestrel, *F.tinnunculus* Linn., 1758 – Kestrel, *Neophron percnopterus* Linn., 1758 - Egyptian Vulture, *Gyps fulvus* Habl., 1783 - Griffon Vulture, *Aegypius monachus* Linn., 1766 - Black Vulture, *Gypaetus barbatus* Linn., 1758 - Bearded Vulture, *Lyrurus mlokosiewiczi* Taczanowski, 1875 - Caucasian Black Grouse, *Tetraogallus caspicus* Gmelin, 1784 - Caucasian Black Grouse, *Alectoris chukar* Gray, 1830 – Chukar, *Francolinus francolinus* Linn., 1766 - Black Francolin, *Perdix perdix* - Grey Partridge, *Coturnix coturnix* Garsault, 1764 – Quail, *Phasianus colchicus* Linn., 1758 - Common Pheasant, *Grus grus* Linn., 1758 - Common Crane, *Leucogeranus leucogeranus* Pall., 1773 - Siberian Crane, *Antropoides virgo* Linn., 1758 - Demoiselle Crane, *Rallus aquaticus* Linn., 1758 - Water Rail, *Crex crex* Linn., 1758 - Corn Crake, *Scolopax rusticola* Linn., 1758 - Eurasian Woodcock, *Glareola pratincola* Linn., 1766 - Collared Pratincole, *Columba palumbus* Linn., 1758 - Wood Pigeon, *C.oenas* - Stock Dove, *C.livia* Gm., 1789 - Rock Dove, *Cuculus canorus* Linn., 1758 – Cuckoo, *Bubo bubo* Linn., 1758 - Eurasian Eagle Owl, *Asio otus* Linn., 1758 - Long-eared Owl, *Otus scops* Linn., 1758 - Scops Owl, *Athene noctua* - Little Owl, *Strix aluco* - Tawny Owl, *Coracias garrulus* - European Roller, *Merops apiaster* - European Bee-eater, *M. persicus* - Blue-cheeked Bee-eater, *Upupa epops* - Eurasian Hoopoe, *Jynx torquilla* - Eurasian Wryneck, *Picus viridis* - Eurasian Green Woodpecker, *Dryocopus martius* - Black Woodpecker, *D.major* - Great Spotted Woodpecker, *D.syriacus* - Syrian Woodpecker, *D.medius* - Middle Spotted Woodpecker, *D.minor* - Lesser Spotted Woodpecker, *Riparia riparia* - Sand Martin, *Ptyonoprogne rupestris* - Crag Martin, *Hirundo rustica* - Barn Swallow, *Delichon urbicum* - Northern House Martin, *Lullula arborea* – Woodlark, *Eremophila alpestris* - Horned Lark, *Anthus trivialis* - Tree Pipit, *A.spinoletta* - Water Pipit, *Motacilla flava* - Western Yellow Wagtail, *M.citreola* - Citrine Wagtail, *Lanius collurio* - Red-backed Shrike, *L.senator* - Woodchat Shrike, *L.minor* - Lesser Grey Shrike, *L.excubitor* - Great Grey Shrike, *Oriolis oriolis* - Golden Oriole, *Sturnus vulgaris* – Starling, *Pastor roseus* - Rosy Starling, *Garrulus glandarius* – Jay, *Pica pica* – Magpie, *Pyrrhocorax pyrrhocorax* - Red-billed Chough, *P.graculus* - Yellow-billed Chough, *Coloeus monedula* - Eurasian Jackdaw, *Corvus corone* - Carrion Crow, *C.cornix* - Hooded Crow, *Bombycilla garrulus* - Bohemian Waxwing, *Troglodytes troglodytes* – Wren, *Prunella collaris* - Alpine Accentor, *P.modularis* – Dunnock, *Locustella fluviatilis* - River Warbler, *Hippolais icterina* - Icterine Warbler, *Iduna caligata* - Booted Warbler, *I.pallida* - Eastern olivaceous Warbler, *Pterocles alchata* - Pin-tailed Sandgrouse, *Regulus regulus* – Goldcrest, *Ficedula albicilla* - Taiga Flycatchers, *Muscicapa striata* - Spotted Flycatcher, *Saxicola rubetra* – Whinchat, *Saxicola torquatus* - Common Stonechat, *Oenanthe oenanthe* - Northern Wheatear, *O.pleschanka* - Pied Wheatear, *O.finschi* - Finsch-s Wheatear, *O.isabelina* - Isabelline Wheatear, *Monticola saxatilis* - European Rock Thrush, *Phoenicurus ochruros* - Black Redstart, *Erithacus rubecula* - European Robin, *Luscinia luscinia* - Thrush Nightingale, *Turdus atrogularis* - Black-throated Thrush, *Turdus pilaris* – Fieldfare, *T.torquatus* - Ring Ouzel, *T.merula* - Eurasian Blackbird, *T.philomelos* - Song Thrush, *T.iliacus* – Redwing, *T.viscivorus* - Mistle Thrush, *Aegithalos caudatus* - Long-tailed Tit, *Sitta europea* - Eurasian Nuthatch. *S.neumayer* - Western Rock Nuthatch, *S. tephronota* - Eastern Rock Nuthatch, *Tichodroma muraria* – Wallcreeper, *Certhia familiaris* - Eurasian Treecreeper, *Calandrella brachydactyla* - Pale Rock Sparrow, *Passer domesticus* - House Sparrow, *Petronia petronia* - Rock Sparrow, *Montifringilla nivalis* - White-winged Snowfinch, *Fringilla coelebs* Linn., 1758 - Common Chaffinch, *Fringilla montifringilla* Linn., 1758 – Brambling, *Chloris chloris* Linn., 1758 - Common Greenfinch, *Ardea purpurea* Linnaeus, 1766 - Purple Heron, *Ciconia nigra* Linnaeus, 1758 - Black Stork, *Milvus migrans* Bodd., 1783 - Black Kite, *Circus macrourus* Gm., 1771 - Pallid Harrier, *Accipiter brevipes* Sev., 1850 - Levant Sparrowhawk, *Buteo rufinus* Cretz., 1827 - Long-legged Buzzard, *Circaetus gallicus* Gmelin, 1788 - Short-toed Eagle,

C*langa clanga* Pall., 1811 - Greater Spotted Eagle, *Clanga pomarina* Brehm, 1811 - Lesser Spotted Eagle, *Falco subbuteo* Linn., 1758 - Hobby Falcon, *Falco columbarius* Linn., 1758 – Merlin, *Otis tarda* Linn., 1758 - Great Bustard, *Tetrax tetrax* Linn., 1758 - Little Bustard, *Glareola nordmanni* Nord., 1842 - Black-winged Pratincole, *Pterocles orientalis* Linn., 1758 - Black-bellied Sandgrouse, *İrania gutturalis* Guer., 1843 - White-throated Robin, *Linaria flavirostris* Linn., 1758 – Twite, *Rhodopechys sanguinea* Could.,1838 - Asian Crimson-winged Finch, *Carpodacus erythrinus* Pall., 1770 - Common Rosefinch, *C.rubicilla* Culd., 1775 - Great Rosefinch, *Loxia curvirostra* Linn., 1758 - Red Crossbill, *Pyrrhula coccothraustes* Linn., 1758 – Hawfinch, *Emberiza cia* Linn., 1766 - Rock Bunting, *E.melanocephala* Scop., 1769 - Black-headed Bunting) have come across. 32 species of birds registered in the occupied territories (*A.purpurea* Linnaeus, 1766 - Purple Heron, *C.nigra* Linnaeus, 1758 - Black Stork, *M.migrans* Bodd., 1783 - Black Kite, *M.milvus* Linn., 1758 - Red Kite, *C.macrourus* Gm., 1771 - Pallid Harrier, *A.brevipes* Sev., 1850 - Levant Sparrowhawk, *B.rufinus* Cretz., 1827 - Long-legged Buzzard, *C.gallicus* Gmelin, 1788 - Short-toed Eagle, *C.clanga* Pall., 1811 - Greater Spotted Eagle, *C.pomarina* Brehm, 1811 - Lesser Spotted Eagle, *A.heliaca* Savigny, 1809 - Asian Imperial Eagle, *A.chrysaetos* Linn., 1758 - Golden Eagle, *Gypaetus barbatus* Linn., 1758 - Bearded Vulture, *Neophron percnopterus* Linn., 1758 - Egyptian Vulture, *Aegypius monachus* Linn., 1766 - Black Vulture, *Gyps fulvus* Habl., 1783 - Griffon Vulture, *Falco cherrug* Gray, 1834 - Saker Falcon, *F.peregrinus* Tunst., 1771 - Peregrine Falcon, *F.subbuteo* Linn., 1758 - Hobby Falcon, *F.columbarius* Linn., 1758 – Merlin, *F.naumanni* - Lesser Kestrel, *L.mlokosiewiczi* Taczanowski, 1875 - Caucasian Black Grouse, *T.caspius* Gmelin, 1784 - Caspian Snowcock, *P.perdix* Linn., 1758 - Grey Partridge, *P.colchicus* Linn., 1758 - Common Pheasant, *O.tarda* - Great Bustard, *T.tetrax* Linn., 1758 - Little Bustard, *G.nordmanni* Nord., 1842 - Black-winged Pratincole, *P.orientalis* Linn., 1758 - Black-bellied Sandgrouse, *S.tephronota* Scharp., 1872 - Eastern Rock Nuthatch, *C.erythrinus* Pall., 1770 - Common Rosefinch, *İ.gutturalis* Guer., 1843 - White-throated Robin) have been included in the II edition of the Red Book (2013). Most of these species are included in the lists of international conventions (Bern, Bonn, CITES, AEWA).

The Lachin sanctuary, Dalidagh and Murovdagh (Gamishdagh) are some of the main habitats of birds of prey included in the Red List of the International Union for Conservation of Nature (IUSN) and the Caucasian Black Grouse - *Lyrurus mlokosiewiczi.* These areas are considered to be one of the international migration corridors for protected birds. The Caucasian tetras and Caspian vultures, which are susceptible to any adverse effects and are endemic to the Caucasus, have settled in the supalpine and alpine zone of this area.

Over half of the species composition of mammals in the country is rare. Their list includes almost all insectivors (Соколов, Тембатов, 1989; Гошуналиев, 1990a, 1990b), about 50% of bats (Рахматулина, 1989b, 1990, 1995a, 1995b), 40% of rodents, up to 60% of predators belong to all ungulates, except wild boar (Quliyev, 1997).

The services of Vereshagin, Asadov and Guliyev, in the study of the fauna of mammals of Azerbaijan are great (Верещагин, 1937, 1942, 1947, 1951a, 1959; Асадов, 1960; Azərbaycanın Heyvanlar aləmi. Onurğalılar, 2004; Кулиев, Аскеров, 2012e; Quliyev, 2015).

According to the article published by Vereshagin in 1942, 56 species related to the theriofauna of the Karabakh territory (8 species of insects, 10 species of bats, 1 species of Lagomorpha, 18 species of rodents, 16 species of predators, 4 species of ungulates) (Vereshagin, 1942), according to Alakbarov 61 species of mammals (insectivores - 8 species, bats - 15 species, *Lagomorpha* - 1 species, rodents - 20 species, predators - 13 species, ungulates - 4 species) are recorded (Алекперов, 1966). According to Guliyev, currently 75 species of mammals (12 species of insects, 20 species of bats, 1 species of rabbits, 25 species of rodents, 13 species of predators, 4 species of ungulates) are recorded in the area (Quliyev, 2021).

8 species out of 13 species of insectivores (Insectivora) in the territory of Karabakh (*Erinaceus concolor* Martin, 1838 - Southern White – breasted Hedgehog, *Talpa levantis* Thomas, 1906 - Levantine Mole, *Sorex raddei* Satunin, 1895 - Radde`s Shrew, *S.satunini* Ognev, 1922 (Syn. *S. caucasica* Satunin, 1913) - Caucasian Shrew, *N.teres* Miller, 1908 (Syn. *N.schelkovnikovi* Satunin, 1913) -

Transcaucasian Water Shrew, *Crocidura suaveolens* Pallas, 1811 - Lesser White-toothed Shrew, *Crocidura leucodon* Hermann, 1780 - Bicolored Shrew, *Crocidura gueldenstaedti* Pallas, 1811 - Gueldenstaedt`s Shrew), 20 species out of 34 species of bats (Chiroptera) (*Rhinolophus hipposideros* Borkhausen,1797 - Lesser Horseshoe Bat, *Rhinolophus blasii* Peters, 1866 - Blasius`s Horseshoe Bat, *Rhinolophus euryale* - Blasius, 1853 Mediterranean Horseshoe Bat, *Rhinolophus mehelyi* Matschie, 1901 - Mehely`s Horseshoe Bat, *Rhinolophus ferrumequinum* Schreber, 1774 - Greater Horseshoe Bat, *Myotis blythii* Tomes, 1857 - Lesser Mouse-eared Bat, *Myotis nattereri* Kuhl, 1817 - Natterer`s Bat, *Myotis emarginatus* Geoffroy, 1806 - Geoffroy`s Bat, *Myotis mystacinus* Kuhl, 1817 - Whiskered Bat, *Plecotus auritus* Linnaeus, 1758 - Brown Long-eared Bat, *Barbastella barbastellus* Schreber, 1774 - Western Barbastelle, *Barbastella leucomelas* Satunin, 1908 - Eastern Barbastelle, *Nyctalus noctula* Schreber, 1774 - Common Noctule, *Nyctalus leisleri* Kuhl, 1817 - Lesser Noctule, *Pipistrellus pipistrellus* Schreber, 1774 - Common Pipistrelle, *Pipistrellus kuhlii* - Kuhl`s Pipistrelle, *Hypsugo savii* Bonaparte, 1837 - Savi`s Pipistrelle, *Eptesicus serotinus* - Serotine Bat, *Minopterus schreibersii* Kuhl, 1817 - Schreiber's Common Bent-winged Bat, *Tadarida teniotis* Rafinesque, 1814 - European Free-tailed Bat), 2 species from *Lagomorpha* (*Lepus europaeus* Pallas, 1778 - European Hare, *Oryctolagus cuniculus* Linnaeus, 1758 - European Rabbit), 19 species of 37 orders from Rodentia, (*Sciurus anomalus* Guldenstaedti,1792 - Caucasian Squirrel, *Hystrix indica* Kerr., 1792 - İndian Crested Porcupine, *Glis glis* L., 1766 - Edible Dormouse, *Dryomys nitedula* Pallas,1778 - Forest Dormouse, *Allactaqa euphratica* Thom., 1881 - Euphrates Jerboa, *A.elater* Licht., 1825 - Small Five-toed Jerboa, *Rattus rattus* L., 1758 - Black Rat, *R.norvegicus* Berk., 1769 - Brown Rat, *Mus musculus* L.,1758 - House Mouse, *Sylvaemus uralensis* Pallas, 1811 - Herb Field Mouse, *S. witherbyi* Thomas, 1902 - Steppe Field Mouse, *S.ponticus* Sviridenko, 1936 - Black Sea Field Mouse, *Crisetulus migratorius* Pallas, 1773 - Grey Dwarf Hamster, *Arvicola amphibius* L., 1758 (*A.terrestris* L., 1758) - European Water Vole, *Mictotus majori* Thomas, 1906 - Major`s Pine Vole, *M.nazarovi* Schidlovsky, 1938 - Nasarov`s Vole, *M.sosialis* Pallas, 1773 - Social Vole, *M.arvalis* - Common Vole, *Ch.nivalis* Martins,1842 - European Snow Vole), 11 species from Carnivora group (*Canis lupus* L., 1758 - GrayWolf, *Canis aureus* L., 1758 - Golden Jackal, *Vul-pes vulpes* L., 1758 - Red Fox, *Mustela nivalis* L., 1758 - Least Weasel, *Martes martes* L., 1758 - Eu-ropean Pine Marten, *Martes foina* Erxleben,1777 -Beech Marten, *Meles meles* L., 1758 - European Badger, *Lutra lutra* L., 1758 - Eurasian otter, *Felissilvestris* Schreber, 1777 - Wild Cat, *Lynx lynx* L.,1758 - Eurasian Lynx, *Ursus arctos* L., 1758 - Brown Bear, *Panthera pardus* L., 1752 - Leopard), 4 species from Artiodactyla group (*Sus scrofa* Linnaeus, 1758 - Wild Boar, *Capra aegagrus* Erxleben, 1777 - Bezoar Goat, *Capreolus capreolus* L., 1758 - European Roe Deer, *Rupicapra caucasica* Lydekker, 1910 - Caucasian Chamois) have been inhabited (Верещагин, 1959; Гошуналиев, 1990, 1990a; Рахматулина, 1990, 1994, 1995a, 1995b; Quliyev, 2015).

Before the occupation of Karabakh, 24 species out of 75 mammals belonging to 6 orders (*Rhinolophus euryale* Blasius, 1853 - Mediterranean Horseshoe Bat, *Barbastella barbastellus* Schreber, 1774 - Western Barbastelle, *Rhinolophus mehelyi* Matschie, 1901 - Mehely`s Horseshoe Bat, *Myotis blythii* Tomes, 1857 - Lesser Mouse-eared Bat, *Rhinolophus hipposideros* Borkhausen, 1797 - Lesser Horseshoe Bat, *Rhinolophus ferrumequinum* Schreber, 1774 - Greater Horseshoe Bat, *Myotis emarginatus* Geoffroy, 1806 - Geoffroy`s Bat, *Tadarida teniotis* Rafinesque, 1814 - European Free-tailed Bat, *Hystrix indica* Kerr., 1792 - İndian Crested Porcupine, *Chionomys nivalis* Martins,1842 - European Snow Vole, *Ursus arctos* L., 1758 - Brown Bear, *Martes martes* L., 1758 - European Pine Marten, *Felis silvestris* Schreber, 1777 - Wild Cat, *Lynx lynx* L., 1758 - Eurasian Lynx, *Capra aegagrus* Erxleben, 1777 - Bezoar Goat, *Capreolus capreolus* L., 1758 - European Roe Deer, *Ovis orientalis* Gmelin, 1774 - Mouflon, *Talpa levantis* Thomas, 1906 - Levantine Mole, *Lutra lutra* L., 1758 - Eurasian otter*)* have been included in the "Red Book" of Azerbaijan (2013). Among these species you can come across Striped Hyena *Hyaena hyaena* L., 1758, Pallas`s Cat - *Oto-*

colobus manul Pallas, 1778, including in the Republican and International Red List. Eurasian Lynx - *Lynx lynx* L., 1758, Leopard *Panthera pardus* L., 1752, Brown Bear - *Ursus arctos* L., 1758, Bezoar Goat – *Capra aegagrus* Erxleben, 1777, European Roe Deer - *Capreolus capreolus* L., 1758 species have been listed in the Red List of the IUSN.

The first edition of the RB, published in 1989, included the names of 108 species of animals, embracing 14 species of mammals, 36 species ofbirds, 13 species of reptiles and amphibians, 5 spe-cies of fish and 40 species of insects. The second edition of the RB, published in 2013, included 223species of rare, endangered and endangered speciesin need of protection (Reshetnikov E.G.2018). Of these, 1 species belongs to the hydrofauna of our republic, 1 species Oligo- chaeta, 1 species Crustacea, 1 species Mollusca, 78 species Insecta, 9 species Pisces, 6 species Am- phibia, 14 species Reptilia, 72 species Aves, and 42 species Mammalia.

As a result of conservation measures included in the I and II editions of the Red Book of Azerbaijan, there is a need to remove from the list of species with a significant increase in their number, as well as to add to the list of species of fauna with a decrease in their number. Undoubtedly, based on international experience, the lists provided by the Red Book of Azerbaijan should be regularly updated and republished every 10 years.

The third edition of the Red Book of Azerbaijan, which is scheduled for publication in 2023, will include 279 species of rare, endangered and endangered species in need of protection. In addition to monitoring of 3 species of aquatic invertebrates and 9 species of fish included in the II edition of the Red Book and to be included in the III edition, the reduction of the number of pearl snail - *Unio mingrelicus* Drouet, 1881 and medicinal leech - *Hirudo orientalis* will be clarified. According to the results of the monitoring to be conducted by researchers, the issue of inclusion of these species and 2 bony fish species in the III edition of the Red Book will be considered.

The second edition of the Red Book of Azerbaijan (2013) includes 77 species of insects. In the third edition, it is proposed to remove 14 species from the list, and to increase the number of species on the updated list to 118 by adding 55 species. It is planned to include 6 species of reptiles in the 3rd edition of the Red Book of Azerbaijan (2013). The 3rd edition should clarify the issue of removing 4 species of birds from the list and adding 15 new species to the previous list, the updated list of mammals, removing the 8 species of mammals from the list of mammal species and including 1 species in the second edition.

As the fauna of our liberated territories has not existed for the last 30 years, monitoring should begin as soon as possible

CONCLUSIONS

According to the literature, 56 species of the insect fauna of previous years in Karabakh and surrounding areas are rare, endemic and endangered species.

7 species of the 53 fish species registered in the watersheds of the Lesser Caucasus, including Karabakh and the liberated territories, are included in the Red Book of Azerbaijan, and 4 species are included in the IUSN Red List.

4 out of 11 species of amphibians registered in Azerbaijan and 35 species out of 63 species of reptiles are found in the Lesser Caucasus natural region. 1 species of turtles, 10 species of lizards and 13 species of snakes are distributed in the fauna of Karabakh. 1 species of amphibians and 7 species of reptiles are included in the IUCN and the Red Book of Azerbaijan (2013).

Prior to the occupation, 32 species out ofabout 200 bird species registered in 16 orders and 57 genera in Karabakh and its environs were included in the Second Edition of the Red Book (2013). Most of these species are included in the lists of international conventions (Bern, Bonn, CITES, AEWA).

24 species out of 75 species of mammals belonging to 6 groups registered before the occupation in the territory of Karabakh were included in the Red Book (2013). Five of them are also included in the Red List of the International Union for Conservation of Nature (IUSN).

The third edition of the Red Book of Azerbaijan (2013), which is scheduled for publication in 2023, includes 279 species of rare, endangered and endangered species under threat.

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Azərbaycan Respublikasının «Qırmızı Kitabı»nın III nəşrinin hazırlanmasına dair: Qarabağ faunasının qırmızı siyahısı

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Məqalə, Qarabağ və ətraf ərazilərin Ermənistan tərəfindən işğalına qədər AMEA Zoologiya institutunun əməkdaşlarının apardıqları tədqiqat işlərinin nəticələri əsasında hazırlanmışdır. 30 ilə yaxın işğal altında olmuş Qarabağ və ətraf ərazilərdə əvvəlki illərdə aparılan tədqiqatların nəticələrinə əsasən həşəratlar faunasının 56 növü nadir, endemik və nəsli kəsilmək təhlükəsində olan növlərdir. Azərbaycanın Kiçik Qafqaz ərazisində qeydə alınan 53 balıq növündən 7-si Azərbaycanın "Qırmızı Kitab" ına (QK), 4 növ isə IUSN-in Qırmızı siyahısına daxil edilmişdir. Həkəri çayında 12, Bəsitçay və Oxçuçaylarında isə 13 növ balığın yayıldığı müəyyən edilmişdir. Kiçik Qafqaz təbii vilayətində Azərbaycanın batraxofaunasına aid 11 növ amfibilərdən 4-nə, herpetofaunasına aid 63 növ reptililərdən isə 35-i qeydə alınır. Qarabağ ərazisində reptililər faunası üzrə tısbağalardan 1, kərtənkələlərdən 10, ilanlardan isə 13 növ yayılmışdır. Amfibilərdən 1, reptililərdən isə 7 növ *İUCN*-nin və QK-a (2013) daxil edilmişdir. İşğala qədər Qarabağ və onun ətraf ərazilərində 16 dəstəyə, 57 fəsiləyə mənsub qeydə alınan 200-ə yaxın quş növündən 32-növ QK-ın II nəşrinə (2013) daxil edilmişdir. Bu növlərin əksəriyyəti beynəlxalq konvenvensiyalarının (Bern, Bonn, CITES, AEWA) siyahılarına daxil edilmiş növlərdir. Qarabağ ərazisində işğala qədər 6 dəstəyə mənsub, 75 növ məməlidən 24 növü Azərbaycanın QK-na (2013) daxil edilmişdir. Bunlardan da 5 növ eyni zamanda Beynəlxalq Təbiəti Mühafizə İttifaqının Qırmızı Siyahısına (İUSN) da daxil edilmişdir. 2013-cü ildə nəşr olunan QK-ın II nəşrinə, nadir, nəsli kəsilmək və təhlükə altında olmaqla, qorunmasına ehtiyac yaranan 223 növ heyvan daxıl edilmişdir. Bunlardan 1 növ *Oligochaeta*, 1 növ *Crustacea*, 1 növ *Mollusca*, 77 növ *Insecta*, 9 növ *Pisces*, 6 növ *Amphibia*, 14 növ *Reptilia*, 72 növ *Aves*, 42 növ *Mammalia* sinfinə aiddir. 2023-cü ildə nəşr edilməsi nəzərdə tutulan QK-ın III nəşrinə, nadir, nəsli kəsilmək və təhlükə altında olmaqla, qorunmasına ehtiyac yaranan 279 növ heyvanın daxil edilməsi nəzərdə tutulur. QK-ın III nəşrinə daxil edilməsi təklif edilən tibb zəlisi və 2 sümüklü balıq növünün məsələsinə aydınlıq gətiriləcək. Qırmızı Kitabın II nəşrinə daxil edilmiş həşəratlar sinifinə aid 77 növdən, III nəşrdə 14 növün siyahıdan çıxarılması, 55 növün isə əlavə edilməsi ilə yeniləşmiş siyahıda olan növlərin sayının 118-ə çatdırılması təklif edilir. Amfibilərin siyahısında (6 növ) dəyişiklik edilməyəcəyi, reptililərin siyahısına isə əlavə 6 növ sürünən daxil edilməsi nəzərdə tutulur. III nəşrdə əvvəlki siyahıya 15 yeni növün daxil edilməsi, məməli heyvanların yenilənmiş siyahısına II nəşrdə məməli heyvan növləri siyahısından 8 növ məməlinin çıxarılması və 1 növünün daxil edilməsi məsələsinə baxılacaq.

Açar sözlər: *Fauna, onurğasız, onurğalı, Qırmızı Kitab, amfibi, reptili, balıq, məməli, İUSN, dəstə, fəsilə*

Подготовка третьего издания «Красной книги» Азербайджанской Республики: Красный список фауны Карабаха

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Статья основана на результатах исследований, проведенных сотрудниками Института зоологии НАНА до оккупации Арменией Карабаха и прилегающих территорий. Согласно исследованиям, проведенным в предыдущие годы в Карабахе и его окрестностях, которые находились под оккупацией почти 30 лет, 56 видов фауны насекомых являются редкими, эндемичными и находящимися под угрозой исчезновения. Из 53 видов рыб, зарегистрированных на территории Малого Кавказа

Азербайджана, 7 занесены в Красную книгу Азербайджана (КК), а 4 вида - в Красный список Международного союза охраны природ (МСОП или IUSN). Установлено, что 12 видов рыб обитают в реке Хакари, а 13 видов - в реках Баситчай и Охчучай. В природной области Малого Кавказа зарегистрировано 4 из 11 видов земноводных, относящихся к батрахафауне Азербайджана, и 35 из 63 видов рептилий, относящихся к герпетофауне. На территории Карабаха из фауны рептилий обитают 1 вид черепах, 10 видов ящериц и 13 видов змей. 1 вид земноводных и 7 видов рептилий включены в МСОП и КК (2013). До оккупации в Карабахе и его окрестностях из зарегистрированных примерно 200 видов птиц, относящихся к 16 отрядам и 57 семействам, 32 вида были включены во второе издание Красной книги (2013 г.). Большинство этих видов внесено в списки международных конвенций (Берн, Бонн, МСОП, AEWA). До оккупации Карабаха из 75 видов млекопитающих, относящихся к 6 отрядам 24 вида были включены в Красную книгу Азербайджана (2013 г.). Пять из них также внесены в Красный список МСОП. Второе издание Красной книги, опубликованное в 2013 году, включает 223 редких и находящихся на грани исчезновения вида. Из них 1 вид относится к классу *Oligochaeta*, 1 вид - *Crustacea*, 1 вид - *Mollusca*, 77 видов - *Insecta*, 9 видов - *Pisces*, 6 видов - *Amphibia*, 14 видов - *Reptilia*, 72 вида – *Aves* и 42 вида относятся к классу *Mammalia*. Третье издание Красной книги, которое планируется опубликовать в 2023 году, будет включать 279 редких и находящихся на грани исчезновения видов. Будет прояснен вопрос о лечебной пиявке и двух костных рыбах, предлагаемых для включения в третье издание Красной книги. Предлагается в третьем издании Красной книги из 77 видов насекомых, включенных во второе издание удалить 14 видов и увеличить количество видов в обновленном списке до 118, добавив 55 видов. Список амфибий (6 видов) не будет изменен, а список рептилий будет включать 6 дополнительных видов. В третьем издании будет рассмотрено включение 15 новых видов в предыдущий список. В списке млекопитающих будет рассмотрено исключение 8 видов из списка во втором издании и включение 1 вида в обновленный список.

Ключевые слова: *Фауна, беспозвоночные, позвоночные, Красная книга, земноводные, рептилии, рыбы, млекопитающие, МСОП, отряд, семейство*

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Geobotanical features of alpine and subalpine vegetation of summer pastures in the East Zangazur economic region and its significance

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The article gives data on the geobotanical investigation of summer pastures in the Kalbajar and Lachin regions of the East Zangazur Economic Region, as well as phytocenological features of subalpine and alpine vegetation based on pre-occupation research. In the wake of the research, phytocenological features, the composition of species, structure, productivity and pasture capacity of alpine and subalpine vegetation of the region were determined. Scientific and practical recommendations were given for the effective utilization of the summer pastures of the liberated from occupation Kalbajar and Lachin districts of the Eastern Zangazur economic region and their improvement.

Keywords: *Phytocenosis, formation, association, dominant, pasture, productivity, pasture capacity, subdominant, endemic*

INTRODUCTION

The division of economic regions indicated in the State Program has a major significance for the purposes of implementation of the “State Program of socio-economic development of the regions of the Republic of Azerbaijan in 2019-2023” approved by the Decree of the President of the Republic of Azerbaijan No. 500 dated January 29, 2019. Therefore, one of the economic regions mentioned in the Decree of the President of the Republic of Azerbaijan dated July 7, 2021 "On the new division of economic regions in the Republic of Azerbaijan" is the East Zangazur economic region. This economic region includes Jabrayil, Kalbajar, Gubadli, Lachin and Zangilan districts (Decree of the President of the Republic of Azerbaijan, 2001; Map of Azerbaijan Republic (Zangazur county), 1918-1920).

Purposeful reforms and large-scale measures implemented in Azerbaijan have further strengthened the economic and military-defense power of our country and laid the groundwork for achieving a glorious victory in the 44-day Patriotic War.

From this point of view, at present, measures are being carried out for the restoration of the liberated territories, including summer pastures, ensuring their future development, creation of the necessary infrastructure and returning of the population to their native lands. In this regard, the research of geobotanical features of alpine and subalpine meadows spread in Kalbajar and Lachin regions in the efficient utilization of natural resources of the East Zangazur economic region, as well as summer pastures, where it allows economic assessment of subsoil pasture lands (Mammadov, 2003).

For this reason, the following research is planned to be carried out in the summer pastures of Kalbajar and Lachin regions, which are surrounded by the Zangazur mountain range and are located on the border with Armenia:

- characterization of the composition of species and structure of vegetation of alpine and subalpine meadow at the level of types, formations and associations;
- development of the classification of phytocenoses according to the principles of dominance;
- determination of pasture productivity, quality of forage and capacity;
- giving recommendations with scientific and practical substantiation for measures of the effective utilization and improvement of pastures.

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MATERIALS AND METHODS

Information on species composition, structure, productivity, forage quality and grazing of Narduseta, Poaeta-Carexetum belonging to alpine meadow, as well as Festuceta-Amoriaetum and Festuceta-Alchemilletum formations which are characteristic of subalpine vegetation is given. These formations which spread over the widest natural habitat in the summer pastures, which are considered to be a rich natural forage base (kept in state ownership) for livestock breeding, as well as nomadic sheep breeding in the highland areas of Kalbajar and Lachin regions that located in the north-western part of the Lesser Caucasus Mountains in the Kalbajar-Lachin economic-geographical region of the East Zangazur economic region (General Scheme on efficient use of natural fodder areas of the Republic of Azerbaijan until 2005 (2005); Aghaguluyev, 2011; Hajiyev et al., 1995; Gurbanov et al., 2017; Prilipko, 1970).

During the research, the systematic taxa and natural habitat of plant species spread in alpine and subalpine vegetation in Kalbajar and Lachin area were clarified according to "Flora of Azerbaijan" (Flora of Azerbaijan, 1950-1961), as "Mountain vegetation of the Lesser Caucasus" (Gurbanov, 2017), the names of species also was given according to S.K.Cherepanov (Cherepanov**,** 1995), V.J.Hajiyev and T.E.Gasimova (Hajıyev et al., 2008). Besides this, references were made to the map of vegetation cover of summer pastures of both districts, including maps authored by Y.M.Isayev (1949), V.J.Hajiyev (2007) and G.S.Mammadov et al. (Vegetation map of Azerbaijan, 2007; Hajıyev et al., 1990).

Phytocenological or geobotanical features of the Lesser Caucasus Mountains located within the territory of the Republic of Azerbaijan have been studied for various purposes by L.I.Prilipko (Prilipko, 1970), V.J.Hajiyev (Hajıyev, 2004; Hajıyev et al., 1977; Gurbanov et al., 2017; Mammadov, 2003), E.M.Gurbanov (Gurbanov et al., 2017) and other botanists.

Indicators related to the classification, productivity, quality of forage and pasture capacity of the area of summer pastures located in the area of Karabakh volcanic plateau of Kalbajar and Lachin district were noted in accordance with the "General Scheme on the effective utilization of Natural Forage Areas of Azerbaijan until 2005" (General Scheme on efficient use of natural fodder areas of the Republic of Azerbaijan until 2005 (2005)).

The total area of natural forage areas (summer pastures, rural pastures and hayfields) located in the territory of Kalbajar region was 77148.0 hectares (according to 1949 data) (Map of the types of natural forage lands of summer pastures of the State fond of nearvillage pastures and haymakings of Kalbajar region of Azerbaijan SSR, 1949). However, the summer pastures of this region are shown in the "General Scheme" at 74,840 hectares.

According to the land balance of the region, the total area of pastures located in Kalbajar administrative district is 93,354 hectares. The pastures in the territory of this district have been used for flocks of sheep or goats (ovine) in 17 administrative districts during the grazing season (summer season) before the Armenian occupation. Currently, more than 9-10 thousand sheep can be fed in the summer pastures of the Kalbajar region.

The climate of the highlands in the Kalbajar region is characterized by cold, harsh, dry and humid winters, and frequent fogging of pastures is typical (Hajıyev et al., 1977; Mammadov, 2003). Such conditions have a positive effect on the grazing of small horned cattle in summer pastures. Here, it is purposeful the grazing of the flocks of sheep in alpine and subalpine meadows during June 15 - October 15 due to the influence of climatic factors.

Here, alpine vegetation formed on the undeveloped fragile grassy mountain-meadow and dense grassy mountain-steppe soils of the alpine and subalpine zone is spread at 2600-3200 meters and above sea level but subalpine vegetation is spread at an altitude of 1800-2500 meters (Aghaguluyev, 2011; Gurbanov et al., 2017; Map of the types of natural forage lands of summer pastures of the State fond of nearvillage pastures and haymakings of Kalbajar region of Azerbaijan SSR, 1949).

The relief of the area is mainly high mountainous, as well as the economic-geographical region of Kalbajar-Lachin occupies the East Goycha in the north-west, Murovdagh in the north, and the Karabakh plateau in the east. The Mikhtoken range stretches in the central part. The highest tops are Gamish (3724 m), Dalidagh (3616 m), Gizilbogaz

(3562 m) And Boyuk Ishigli (3552 m), As well as the Omar Pass (3200 m).

Cretaceous, Paleogene, Neogene and Anthropogenic sediments located in this area are widespread. The main rivers are the Tartar (which flows into the Sarsang Reservoir) and the Lev River, the Tutgunchay and the Bazarchay which are its tributaries; There are small and large Alagol lakes and Zalkha lakes (Gurbanov et al., 2017). The headwater of Tartar River begins in the Lesser Caucasus from an altitude of 3120 meters and has 31 tributaries. Areas of summer pastures are rich in springs (Jeyran spring, Yuz spring, Kirkhbulag, Aygir spring, etc.). Herds of cattle grazing in the summer pastures are supplied with water through the water of these rivers and springs.

The alpine and subalpine meadows of the summer pastures of the Kalbajar district, located in the Eastern Zangazur economic region, are not fully developed, and are spread on peaty mountain meadow and dense grassy mountain meadow-steppe soils (Vegetation map of Azerbaijan, 2007; General Scheme on efficient use of natural fodder areas of the Republic of Azerbaijan until 2005, 2005; Gurbanov et al., 2017; Hajıyev et al., 1990). However, alpine carpets and tall grass meadows are found here in a small area. Alpine carpets are found in the form of spots on bare rocks, boulders and primitive soils at an altitude of 3200 m above sea level, especially in the high mountains of the area (Gurbanov et al., 2017). In this meaning, *Koeleriaeta albovi, Alchmilleta sericata, Narduseta stricta, Taraxacumeta Stevenii, Zernaeta variegata, Plantago lanceolata, Sibboldia parviflora* and others. species are considered major edificators to various herbaceous low statured alpine carpets (Aghaguluyev, 2011).

The territory of Lachin region is 1840 km^2. The relief is mostly highland. The southeastern slopes of the Karabakh plateau are located in the east of the region, and the Mikhtoken range is located in the north; It is calculated that the highest top is Gizilbogaz Mountain (3594 m). The main rivers of this region are Hakari, Shelva and Pirjanis. The Hakari River is formed at the confluence of the Shalva and Hochazsu rivers, which flow at an altitude of 950 m above sea level. It is calculated that the source of the Shelvachay is the Mikhtoken range (3411 m). Garagols in the territory of summer pastures and Alagols located on the border with Armenia are available. The total area of summer pastures located in the region is 70,156 ha (General Scheme on efficient use of natural fodder areas of the Republic of Azerbaijan until 2005, 2005) and the usable pasture area is 53,334 hectares.

Garagol is located on the border of Lachin region of the Republic of Azerbaijan and Gorus region of Armenia (considered as Eastern Zangazur) (Map of Azerbaijan Republic (Zangazur county), 1918-1920). This lake is surrounded by the territory of the Karabakh reserve; Herds of sheep grazing in summer pastures and the pastures around this lake are provided with water from the lake.

Ishigli Garagol State Nature Reserve was established on October 17, 1987 by the decision of the directive bodies. The reserve is located in the southern part of the Karabakh volcanic plateau on the slope of Mount Ishigli (3552 m) at an altitude of 2650-2700 m (Aliyev et al., 1993). Here (in Lachin region) the cold climate type with dry winters prevails (Hajıyev et al., 1977); the average annual temperature is 5°C and the amount of annual precipitation is 700 mm.

The dry area of the reserve that surrounds the lake consists of typical alpine meadows of the highland belt. There are more than 100 species belonging to 27 families and 68 genera in the wild flora of this place (Aliyev et al., 1993).

RESULTS AND DISCUSSION

The most widespread alpine and subalpine vegetation in the summer pastures of the Kalbajar region (General Scheme on efficient use of natural fodder areas of the Republic of Azerbaijan until 2005, 2005) includes the following associations:

1. *Narduseta stricta*; 2. *Poaeta badensis – Amorietum ambigum*; 3.*Festuceta ovina – Trifolietum ambigum*; 4. *Agrostiseta planifolia*; 5. *Zernaeta variegata*; 6. *Koeleriaeta albovi* (with thing stem) – *Alchmilleta sericata*; 7. *Phleumeta alpinum*; 8.*Taraxacumeta Stevenii – Poaetum pratense*.

The following formations and associations can be noted in alpine and subalpine vegetation happen to meet in a wide natural habitat in summer pastures located in the highland zone of the Lachin region:

1. Agrosieta tenuis – Koelerietum albovii; 2. *Trifolieta medium – Festucetum pratensi*s; 3. *Dactyliseta glomerata – Festucetum pratensis*; 4. *Festuceta ovina – Alchemilletum sericata*; 5. *Hordeumeta violaceum – Trifolietum pratense*; 6. *Poaeta badensis – Carexetum tristis*.

According to V.J.Hajiyev (Hajıyev, 2004), the floristic composition of summer pastures vegetation in the ecosystem of highland vegetation of Azerbaijan consists of 250 species. More than 350 types of fodder plants, 200 species of essential oil plants, 800 species of medicinal plants, more than 100 species which contain tannins, 300 species of melliferous plants etc. are spread in these pastures. In particular, according to the author's note, alpine and subalpine phytocenoses are represented in 9 formations (Gurbanov et al., 2017) in the mountainous belt of the Lesser Caucasus.

The study shows that subalpine and alpine meadows are spread at an altitude of 1800-2200-3000 m above sea level in the high mountain ranges of the Greater and Lesser Caucasus of Azerbaijan, in the high mountains of Talysh and Nakhchivan AR; Alpine meadow vegetation is found at an altitude of 2400-3200 m. The edificators of subalpine meadows were recorded with highgrass vegetation, in contrast the dominant and subdominants of alpine meadows were recorded with short stature plants (Gurbanov et al., 2017).

The phytocenological classification of alpine and subalpine vegetation in summer pastures (Vegetation map of Azerbaijan, 2007; Hajıyev, 2004; Gurbanov et al., 2017; Hajıyev, et al., 1990; Map of the types of natural forage lands of summer pastures of the State fond of nearvillage pastures and haymakings of Kalbajar region of Azerbaijan SSR, 1949) in the territory of Kalbajar and Lachin districts of East Zangazur economic region is given below:

I.Alpine vegetation type.

Grain grass *Hordeum brevisubulatum* formation class:

1. *Narduseta formation* group.

Narduseta stricta (matgrass) association/

Carex tristis formation class

Poaeta – Carexetum formation group.

Poaeta badensis – Carexetum tristis association.

II. Subalpine vegetation type.

Graingrass – legume grass formation class (*Fabaceae*) *Astragalus* captiosus

Festuceta - Amoriaetum formation group.

Festuceta pratensis – Amoriaetum ambigua association.

Vvarious herbs - *Hordeum brevisubulatum-Herbose*to) formation class

Festuceta – Alchemilletum formation group.

(*Festuceta ovina* (Sheep's fescue) – *Alchemilletum sericata* association.

Research shows that 21 species are found in the species composition of the *Narduseta stricta* (matgrass) association of the *Narduseta* formation, in the summer pastures of Kalbajar region (in the direction of the source of the Ayrim river and Goycha range) at an altitude of 2845 m above sea level, in the alpine vegetation.

2 species (9.5%) belong to shrubs, 1 species (4.8%) to semi-shrubs and 18 species (85.7%) to perennial grasses according to the life forms (Hajiyev et al., 1995; Gurbanov et al., 2017; Prilipko, 1970) or biomorphological analysis of the species composition of the association; 8 species (38.1%) represented by mesophytes, 2 species (9.5%) by mesoxerophytes and 11 species (52.4%) by xreophytes from the same amount of species according to the analysis of plants on ecological groupings.

The abundance of phytocenosis monodominant *Nardus stricta* L. (matgrass) is estimated at 4-5 points. The vegetation has 2 floors according to the structure or structure of the association. The total project coverage is 70-90%.

The names of the species of *Rosa tuschetica* Boiss., *Thymus grossheimii* Ronn., and *Delphinum speciosum* Bieb. which from the endemics (Gurbanov et al., 2017) of the Caucasian natural habitat mentioned in the species composition of the Narduseta formation are included in the "Red Book of Azerbaijan" (2003) (Red Book of the Republic of Azerbaijan, 2013). Therefore, based on the geobotanical characteristics of alpine vegetation in the area, it is recommended to implement measures for the efficient utilization of summer pastures in Kalbajar region (General Scheme on efficient use of natural fodder areas of the Republic of Azerbaijan until 2005, 2005; Aghaguluyev, 2011; Hajıyev, 2004; Gurbanov et al., 2017).

29 species occur in species composition of association of Festuceta pratensis- Amoriaetum ambigua of the subalpine vegetation spread in the summer pastures of Kalbajar region, in the "Sususlug plateau" at an altitude of 2415 m above sea

level, in dense grassy mountain meadows - steppe-type soils.

4 species (13.8%) shrubs, 2 species (6.9%) shrubs and 23 species (79.3%) perennial grasses participate in the composition of species based on biomorphological analysis of land plants (embryophytes); 14 species (48.3%) are represented by mesophytes, 4 species (13.8%) by mesoxerophytes, 10 species (34.4%) by xerophytes and 1 species (3.5%) by hydrophytes from the same amount of species according to the ecological analysis.

İt is considered that the dominant of the formation is Amoria ambigua Bieb. Sojak., and its abundance is 3-4 points and subdominant is Festica pratensis Huds., its abundance is estimated by 2-3 points.Vegetation consists of a three-storey structure. The total project coverage is 60-80%.

The species of Thymus transcaucasica Ronn., and *Phleum pratense* L. are endemic plants of Caucasian natural habitat which occur in the species composition of vegetation (Yaroshenko, 1961). Therefore, it is expedient to protect the relevant plants during the improvement of summer pastures of the Kalbajar region.

Research has shown that natural phytocenoses spreading in summer pastures of the Lachin region, located in the mountainous area of the Lesser Caucasus, including indicators on subalpine meadows have higher species composition, abundance, as well as formation productivity and grazing capacity compared to alpine meadows (General Scheme on efficient use of natural fodder areas of the Republic of Azerbaijan until 2005, 2005; Gurbanov et al., 2017).

The *Poaeta badensis-Carexetum tristis* association is represented in the *Poaeta-Carexetux* formation of alpine vegetation on the grassy mountain-meadow soils on the high slope (at an altitude of 3171 m above sea level) between Alagol and Garagol located in the summer pastures of the region.19 species of land plants (embryophyta) in the species composition of this association are found; of which 4 species (21.1%) belong to shrubs and 15 species (78.9%) belong to perennial grasses; 7 species (36.8%) are characterized by xerophytes, 2 species (10.5%) by mesoxerophytes, 9 species (47.4%) by mesophytes and 1 species (5.3%) by hydrophytes from the same amount of plants.

The dominant type of phytocenosis is *Carex tristis Bieb.* İts abundance is 3-4 points and subdominant is *Alpine Poa badensis* Haenke and abundance is 2-3 points. Due to its structure, the vegetation of the formation three-storeyed. The total project coverage varies between 60-85%.

Subalpine meadows spread on dense grassy highland-meadow-steppe soils, at the foot of "Parmachitepe" at an altitude of 2328 m above sea level, *Festuceta-Alchemilletum* formation, *Festuceta ovina - Alchemilletum sericata* association are represented in summer pastures areas that spread in the north-east of Garagol reserve in the territory of the Lachin district.

2 species (6.5%) are shrubs, 1 species (3.1%) are semi-shrubs and 28 species (90.3%) are perennial grasses according to the biomorphological analysis of 31 species of higher flowering plants registered in the species composition of the association;18 species (58.1%) belong to mesophytes, 5 species (16.1%) to mesoxerophytes, 6 species (19.3%) to xerophytes and 2 species (6.5%) to hydrophytes from the same number of species according to ecological analysis.

The abundance of *Alchemilla sericata* Reichenb. ex Bus. of the dominant phytocenosis is estimated at 4-5 points and abundance of *Festuca ovina L.* of subdominant is 2-3 points. Vegetation is three-tiered. The total project coverage varies between 60-80%.

The species of *Thymus collinus* Bieb., *Taraxacum confusum* Schischk., and *Rosa sachokiana* P.Jarosch. are endemic plants of Caucasian natural habitat which occur in the species composition of vegetation (Gurbanov et al., 2017; Yaroshenko, 1961). Therefore, it is recommended to protect these plant species by improvement measures of the summer pastures.

A number of geobotanical sources provide information on the productivity, forage quality and capacity of alpine and subalpine vegetation spread within the territory of the Lesser Caucasus of Azerbaijan (General Scheme on efficient use of natural fodder areas of the Republic of Azerbaijan until 2005, 2005; Hajıyev, 2004, 2008; Hajıyev, et al., 1990).

Productivity, forage quality and capacity of alpine and subalpine vegetation located in summer pastures in the territory of Kalbajar and Lachin districts were determined.

The following are the indicators of the productivity of the *Narduseta* formation of alpine meadow vegetation on botanical grass groups spread insummer pastures in the territory of the district. The average yield of the formation is calculated according to the wet mass which is consumed as 19.2 centner/ha (*Poaceae* 8.4 centner/ha, legume grass 4.6 centner/ha, various herbs 6.2 centner/ha) and in dry mass is 9.6 centner/ha (*Poaceae* 4.2 centner/ha, legume grass 2.3 centner/ha, various herbs 3.1 centner/ha).

Here, the productivity of alpine vegetation in the Narduseta formation (921 ha) that is spread in the summer pasture, was calculated 9.6 cents / ha, forage unit 52.7 kg per 100 kg of dry grass. The weight on 1 hectare of pasture was calculated as 4.3 head of cattle and the capacity is 3960 heads, providing that 1.3 feed units are accepted as daily feed norm for small horned cattle.

Subalpine meadow plant *Festuceta* - the productivity of the formation of *Amoriaetum* is higher than that of the alpine meadow *Narduseta phytocenosis*, and also plays an important role in the forage reserves of summer pastures.

Average yield in wet mass according to the botanical grass groups of this formation is 35.1 centner/ha (grains 11.8 centner/ha, legumes 15.6 centner/ha, various herbs 7.7 centner/ha) and 35.1 centner/ha (grain grass 11.8 centner/ha, legumes 15.6 centner/ha, various herbs 7.7 centner/ha) and in dry mass it is 16.7 centner/ha (grain grass 5.6 centner/ha, legume grass centner/ha and various varieties 3.6 centner/ha).

Formation of *Festuceta* - *Amoriaetum* which occurs in the widest natural habitat of summer pastures of the region were determined as 6292 ha, productivity in dry mass as (16.7 centner/ha), feed unit as (57.9 kg in 100 kg of dry grass), grazing period in pastures as (120 days). The weight on 1 hectare of pasture was calculated as 6,4 head of cattle and the capacity is 40268 heads, providing that 1.3 feed units are accepted as daily feed norm for small horned cattle (General Scheme on efficient use of natural fodder areas of the Republic of Azerbaijan until 2005, 2005).

Productivity of Poaeta-Carexetum formation on botanical grass groups was calculated in the most widespread alpine meadow in summer pastures in Lachin region (General Scheme on efficient use of natural fodder areas of the Republic of Azerbaijan until 2005, 2005). In particular, the average productivity of this formation is 21.2 centner/ha (grain grass 7.1 centner/ha ha, legume grass 4.5 centner/ha, various herbs and stubbles 9.6 centner/ha) due to the wet biomass which is eaten.

Feed unit (54.8 kg in 100 kg of dry grass), grazing period in pastures 90 days) were determined in the phytocenosis of Poaeta - Carexetum (4981 ha) which spread in the widest natural habitat of summer pastures. The weight on 1 hectare of pasture was calculated as 4,5 head of cattle and the capacity is 22415 heads, providing that 1.3 feed units are accepted as daily feed norm for small horned cattle (General Scheme on efficient use of natural fodder areas of the Republic of Azerbaijan until 2005, 2005).

The productivity of the subalpine meadow *Festuceta - Alchemilletum* formation that widespread in summer pastures of this region was found in botanical grass groups. The productivity of the formation is higher than that of the *Poaeta-Carexetum* formation.

Formation of *Formuceta-Alchemilletum* which is spread summer pastures in the highland areas of the region was determined as 2469 ha, yield productivity in dry mass as 17.2 centner/ha, forage unit as (62.2 kg per 100 kg of dry grass), grazing period of vegetation as 120 days. The weight on 1 hectare of pasture was calculated as 6.7 cattles and the capacity is 16542 heads, providing that 1.3 feed units are accepted as daily feed norm for small horned cattle (General Scheme on efficient use of natural fodder areas of the Republic of Azerbaijan until 2005, 2005).

163510 hectares of summer pastures (93354 ha in the territory of Kalbajar district and 70156 ha in the territory of Lachin district) assigned to the administrative regions of the country are used as a natural fodder source by legal entities and individuals for the development of sheep breeding in the summer pastures of Kalbajar and Lachin districts located in the territory (In the economic-geographical region of Kalbajar-Lachin) of East Zangazur economic region.

In the territory of the Kalbajar region, 93,354 hectares of summer pastures were assigned to 17 regions (Beylagan, Agjabadi, Barda, Tartar, Samukh and other regions) (General Scheme on efficient use of natural fodder areas of the Republic of Azerbaijan until 2005, 2005). The capacity of

93,354 hectares of summer pastures in the Kalbajar region contains 4.0 cattles. The total grazing capacity of summer pastures in this region is calculated as 375,226 head of cattle.

Summer pastures in the territory of Lachin district are assigned to 8 regions (Jabrayil, Fuzuli, Agdam, Imishli and other regions). Grazing of 275156 heads (average 4 heads per hectare) small horned cattle on 70,156 hectares in the territory of this region is calculated.

Over the past 30 years, the summer pastures of both regions have been severely affected by pasture erosion and the "ecocide process". Therefore, the effective utilization and improvement of alpine and subalpine vegetation based on the previously mentioned geobotanical features to prevent soil and vegetation degradation in the summer pastures of these regions is of great economic and environmental importance. (Aghaguluyev, 2011; Hajıyev, 2004; Gurbanov et al., 2017).

The degradation of land vegetation continues as a result of the violation of the ecological balance due to the negative impact of anthropogenic and natural factors in the summer pastures of the Kalbajar and Lachin districts. For that reason, the intensification of such negative effects creates difficulties protection of fodder, medicine, endemic and species included in the "Red Book of Azerbaijan" growing there, as well as safeguard. In this regard, it is recommended to implement the following measures on a scientific and practical basis for the restoration of soil fertility and vegetation (biodiversity) in the summer pastures of the East Zangazur economic region:

- grazing of cattle with the application of pasture rotation
- surface improvement on eroded slopes, as well as the destruction of harmful and poisonous plants in some pastures;
- application of sowing and fertilization of perennial forage crops that form grass according to agronomic rules;
- effective utilization of alpine and subalpine meadows in summer pastures after vegetation restoration.

CONCLUSIONS

1. 21 species of land plants are found in the species composition of *Narduseta* formation of alpine vegetation, and 2 of them are shrubs, 1 is semi-shrub, 18 are perennial grasses; there are 8 types of mesophytes, 2 types of mesoxerophytes and 11 types of xerophytes. The species of *Poaeta - Carexetum* formation includes 19 species, including 4 species of shrubs, 15 species of perennial grasses;7 types of xerophytes, 2 types of mesoxerophytes, 9 types of mesophytes and 1 type of hydrophytes are recorded.
2. The species composition of the formation of Subalpine plant *Festuceta - Amoriaetu*m consists of 29 species. There are 4 types of shrubs, 2 species of semi-shrubs, 23 species of perennial grasses; It is characterized by 14 species of mesophytes, 4 species of mesoxerophytes, 10 species of xerophytes and 1 species of hydrophytes. There are 31 species of land plants in the species of the composition of *Festuceta-Alchemilletum* formation. 2 species are shrubs, 1 species is semi-shrub, 28 species are perennial grasses; There are 18 species of mesophytes, 5 species of mesoxerophytes, 6 species of xerophytes and 2 species of hydrophytes.
3. Studies show that the average productivity of *Narduseta* and *Poaeta-Carexetum* formations of alpine vegetation formed in summer pastures in the territory of Kalbajar and Lachin regions is defined 9.6 and 10.6 centner/ha, as well as 16.7-17.2 centner/ha for the formation of *Festuceta-Amoriaetum* and *Festuceta-Alchemilletum* of subalpine vegetation.
4. As a result of calculations, it was found that the forage unit of 100 kg of dry grass of Narduseta formation of the alpine plant is 52.7 kg, the forage unit of *Poaeta-Carexetum* formation is 54.8 kg per 100 kg of dry grass mass. There are also 57.9 kg of forage unit per 100 kg of *Festuceta - Amoriaetum* formation of the subalpine vegetation and *Festuceta-Alchemiletum* have 62.2 kg of forage unit per 100 kg of dry grass.
5. According to the pasture capacity, it was determined that it is possible to graze 4.3-4.5 head of small horned cattle in the alpine vegetation of the East Zangazur economic region, and 6.4-6.7 heads of small horned cattle in subalpine vegetation.

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Şərqi Zəngəzur iqtisadi rayonu ərazisində yay otlaqlarının alp və subalp bitkiliyinin geobotaniki xüsusiyyətləri

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Məqalədə Kəlbəcər və Laçın rayonlarının yay otlaqlarının alp və subalp bitkiliyinin geobotaniki xüsusiyyətlərinin tədqiqinin nəticələri öz əksini tapmışdır. Alp və subalp bitkiliyə aid olan otlaqların fitosenoloji xüsusiyyətləri (növ tərkibi, quruluşu və formasiyaların məhsuldarlığı) və otlaq tutumu tərəfimizdən öyrənilmişdir. Tədqiq olunan regionun yay otlaqlarının səmərəli istifadəsi yolları və yaxşılaşdırılması tədbirləri barədə tövsiyyələr verilmişdir.

Açar sözlər: *Fitosenoz, formasiya, assosiasiya, dominant, otlaq, otlaq tutumu, məhsuldarlıq, subdominant, endemik*

Геоботанические особенности альпийской и субальпийской растительности летних пастбищ Восточно-Зангезурского экономического района

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В статье излагаются результаты исследований геоботанических особенностей альпийской и субальпийской растительности летних пастбищ Кельбаджарского и Лачынского районов, которые используются для отгонного овцеводства. Нами изучены фитоценотические особенности (видовой состав, структура и урожайность формаций) и емкость пастбищ, относящихся к альпийской и субальпиской растительности. Рекомендованы мероприятия, направленные на рациональное использование и улучшение летних пастбищ данного региона.

Ключевые слова: *Фитоценоз, формация, ассоциация, доминанта, пастбище, емкость пастбища, продуктивность, субдоминанта, эндемик*

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Fauna of Karabakh and liberated territories and prospects of reintroduction of some largest mammals

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The article clarifies the fauna of Karabakh and the liberated territories and the reintroduction of some large mammals to historical sites on the basis of available literature. Based on the literature data, 56 species of insect fauna in Karabakh and the liberated territories are rare, endemic and endangered. Of the 53 species and subspecies of fish found in the water basins of the Azerbaijani part of the Lesser Caucasus, 7 species are included in the Red Data Book of Azerbaijan (2013), and 4 species are included in the IUSN Red List. 4 out of 11 species of amphibians belonging to the batrachafauna of Azerbaijan and 35 out of 63 species of reptiles belonging to the herpetofauna are found in these areas. Of the 367 species of birds that existed in Azerbaijan before the occupation, 200 species were found in these areas (Currently, Azerbaijan's ornithofauna consists of 407 species of birds.). At present, 115 species of mammals have been registered in Azerbaijan. Before the occupation, 75 mammal species belonging to 6 orders were registered in the territory of Karabakh. Before the occupation, 24 species were included in the "Red Book" of Azerbaijan (2013). In the liberated areas, it is possible to begin the recovery of the population of some of the species of several largest mammals that have recently become extinct (Gazelle - *Gazella subgutturosa* Guldenstaedt, 1778, Caucasian noble deer - *Cervus elaphus* Ogilbu, 1870, Chamois - *Rupicapra rupicapra* Linnaeus, 1758). Historical conditions have been created for the study of the liberated territories and the reintroduction of the listed populations to their historical areas: territories of Aghdam, Fizuli, Jabrayil, Zangilan, where gazelle possibly exists, Caucasian red deer can be found in the territories of Kalbajar, Lachin, Gubadli and Zangilan districts, chamois in the Murovdag range.

Keywords: *Azerbaijan, Karabakh, fauna, fish, amphibians, reptiles, birds, mammals, reintroduction, Red Book*

INTRODUCTION

Karabakh, the charming corner of Azerbaijan and its surrounding regions, has always been distinguished by its natural conditions, sharply different from other regions of Azerbaijan, by the richness of its fauna diversity. The territory of Karabakh makes up 1/6 of the total territory of the republic (plain, mountainous and high mountainous). The territory of Karabakh is one of the richest territories of our republic due to its fauna diversity. Along with the destruction of cultural monuments in the occupied territories of Azerbaijan by the Republic of Armenia, as a result of long-term, targeted environmental terror, the habitats of animals in Karabakh were destroyed, their populations were killed, these areas became dead zone. As a result of successful counter-offensive operations launched by the Azerbaijani Army against the occupying Armenian armed forces on September 27, 2020, under the leadership of President, Supreme Commander-in-Chief Ilham Aliyev, our occupied lands were liberated for 44 days. The measures taken by the state in Karabakh will create conditions for the restoration of natural ecosystems in

the occupied territories and the sustainable development of historically formed biodiversity in the region. Urgent systematic scientific research should be launched to assess the current ecological condition of our fauna in the liberated Karabakh and surrounding areas. The purpose of the article is to clarify the reintroduction of some largest mammals to their historical habitats on the basis of literature data on the fauna of Karabakh and the liberated territories.

MATERIALS AND METHODS

Existing literature information was used in writing the article.

RESULTS AND DISCUSSION

The richness of the vegetation of Karabakh and the liberated territories, the wide diversity of landscape and biotope features affect the richness of the fauna. 53 species and subspecies of fish are distributed in the water basins of the Azerbaijani part of the Lesser Caucasus, of which 7 species are included in the "Red Book" of Azerbaijan (2013), and 4 species are included in the Red List of IUSN. Karabakh and the liberated territories are rich in reservoirs (rivers, lakes, reservoirs, springs, etc.). The ecological terror inflicted on our nature for almost 30 years has also affected the fish fauna formed here for many years. It should be noted that the ichthyofauna of these areas is very poorly studied. The ichthyofauna of the Hakari rivers, one of the largest rivers in the liberated territories, was studied in the 60s of the last century by Y.Abdurrahmanov (1966) and the ichthyofauna of Basitchay and Oxchuchay in the 70s by Mamedova, Nasirov (1975). The author determined that 12 species of fish are distributed in the Hakari River and 13 species of fish in the Basitchay and Oxchuchay rivers. At present, research should be launched to obtain accurate information on the ichthyofauna of water bodies in Karabakh and the liberated territories. The herpetofauna of the area has been studied by researchers in different years (Алиев, 1975; Алекперов, 1966; Ахмедов, 1981; Джафарова, 1979, 1981, 1982). 4 out of 11 species of amphibians belonging to the batrachafauna of Azerbaijan and 35 out of 62 species of reptiles belonging to the herpetofauna are registered in the area. One species of amphibians found in the Lesser Caucasus and adjacent foothills of Azerbaijan is included in the Red List of IUCN, and 6 species of reptiles are included in the IUCN and the Red Book of Azerbaijan (2013). The fauna of the Lesser Caucasus was richer than that of other groups of animals. Of the 367 species of birds that existed in Azerbaijan before the occupation (currently 407 species are found in Azerbaijan), 200 species were found in this area. 23% of these species are included in the Red Data Book of Azerbaijan (2013) with various protection statuses. At present, 115 species of mammals have been registered in Azerbaijan. Before the occupation, 24 species out of 75 mammal species belonging to 6 groups in the territory of Karabakh were included in the “Red Book” of Azerbaijan (2013). Elimination of damage to our fauna as a result of the occupation, restoration or reintroduction of destroyed fauna species should be the focus of attention. It will take a long time for large mammalian populations to recover. Although the decline has been recorded among mammals, birds and fish over the past period, the most dangerous situation is with mammals. From the first half of the twentieth century until 1959, research on even-toed ungulates belonged to N.Vereschagin (Vereschagin, 1937, 1939, 1940, 1951, 1959). Research in this direction was continued by M.Safarov in the following years (Сафаров, 1961). In the 60s of the last century, Alakbarov in his monograph "Mammals of South-West Azerbaijan" gave general information about the distribution and a number of ecological features of gazelles, roe deer, wild boar and bezoar goats (Алекперов, 1966). Currently, the situation in Karabakh and the liberated territories of the Lesser Caucasus has reached a crisis point. Rare, scientifically and economically valuable species, such as bezoar goats, roe deer and wild boar, are likely to be completely extinct. *Gazella subgutturosa* Güldenstaedt, 1780 is considered the least common species in the mammal fauna which has a very light slender body structure, jida height 60-80 cm body length 90-115 cm, weighing 18-33 kg. In time, gazelles could be found in all plains and foothills of Azerbaijan. In the middle of the 20th century, gazelles were still found in the Ganja-Gazakh and Mil

plains (Vereshchagin, 1959; Alekperov, 1966; Guliyev, 1981; Guliyev, Asekrov, 2010, 2012; Guliyev, 1998, 2004, 2011, 2015). The main habitats of gazelles in the world are the desert and semi-desert regions of Iran, Afghanistan, West Pakistan, Southern Mongolia, Northwest China, Uzbekistan, Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan. In the South Caucasus, the specific historical and geographical areas where gazelles are distributed, cover the Kura-Araz lowland, along the Kura River to Tbilisi, and along the Araz River cover all lowlands and foothills (Dyukov, 1930; Flerov, 1935; Vereshagin, 1942; Dementev, 1945; Mambetjumaev, 1955; İshunin, 1956).

In the South Caucasus, the territory of Azerbaijan is considered to be a relatively most common area for this animal (Vereshagin, 1937; 1939; 1947). Based on the literature sources, gazelles were widespread in the Acinohur, Kurakchay valley, Eldar plain, Turt-Sarija, Karabakh, Mil, Mugan plains, Gobustan steppes until the 1940s, and their number began to decline sharply until the 1950s (Vereshagin, 1937; 1939; 1947; 1959). During the aerial survey in 1960-1961, a total of 131 gazelles were found in the above-mentioned areas (14.3 thousand km²) (Кузмин, Шадилов, Кулиев, 1985). In the Mugan Plain, the main densely populated area, gazelles have been completely eradicated. The main reason for this was the hunting of gazelles and the lack of any protection work. As a result of Guliyev's research, modern habitats were compared with the former habitats of gazelles (Guliev, 1998; Musaev, Guliyev, Guliyev, 2010; Guliyev, 2015) and their reintroduction was clarified (Fig. 1).

Currently, a successful program to restore the historical habitat of gazelles is being implemented in the country. The project "Protection, reintroduction, and restoration of historical habitats of gazelles in the territory of the Republic of Azerbaijan" has been launched in order to achieve the restoration of gazelles in new areas by releasing them to their existing historical habitats. To date, more than 300 animals have been released in 6 areas.

For the first time in Azerbaijan, gazelles were relocated to a number of potential reintroduction areas as a result of the application of an improved reintroduction method developed by scientists at the Institute of Zoology of the National Academy of Sciences (Guliyev, Askerov, 2011). New herds of gazelles released into the territory of Acinohur plain, Aggol, Absheron national parks, Gobustan plateau are increasing.

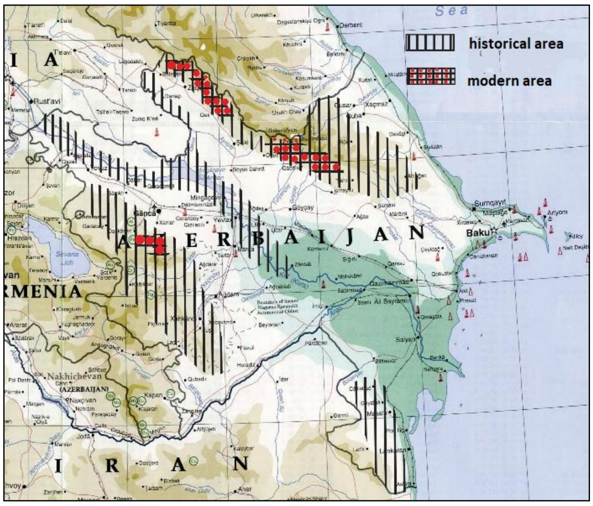


Fig. 1. Historical and modern habitat of gazelles in Azerbaijan (Guliyev, 2015)

The territories of Aghdam, Fizuli, Jabrayil, and Zangilan districts liberated from occupation should be studied for this purpose and, where possible, gazelle herds should be restored. Based on the literature sources, the range of deer or Caucasian deer (*Cervus elaphus* Ogilbu, 1870) in Azerbaijan consists of limited areas (Fig. 2) and is found in very few areas (Dementev, 1933; Aliyev, 1965).

The former area of deer in Azerbaijan covered all-mountain and plain forests and mountain meadows. Vereshagin reports that in the early twentieth century in the lower forest belts of Khachmaz, no more noble deer are found (Верещагин, 1959; Quliyev, 1998a; 2003b; 2008a; 2013v). In the upper forest belts of Gusar, this animal became extinct in the 80s of the XIX century. Until the end of the 19th century, noble deer was found in the reeds and tugai forests in the middle and lower reaches of the Kura River. The complete disappearance of the noble deer in Karabakh, in the Zayamchay valleys, and in the mountain forests of Shamkir dates back to the 1920s. According to Asadov, the areas of noble deer in Azerbaijan cover a very large area - the foothills of the Greater and Lesser Caucasus, the upper mountain forests, and the tugai forests of the Kur-Araz in the lowlands (Асадов, 1960). Deer have either left or been destroyed in the Karabakh region.

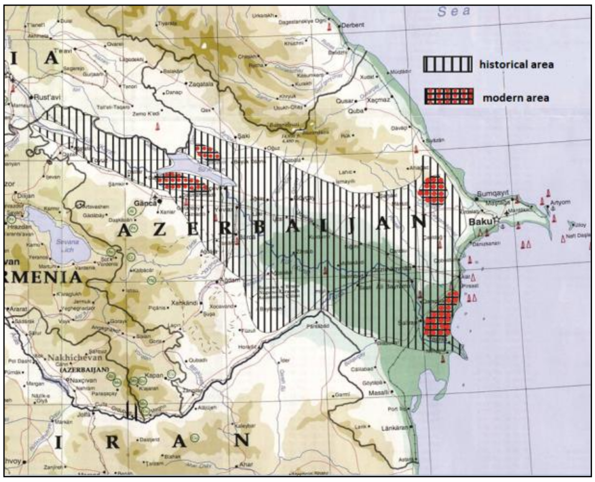


Fig. 2. Historical and modern habitat of deer (Guliyev, 2015)

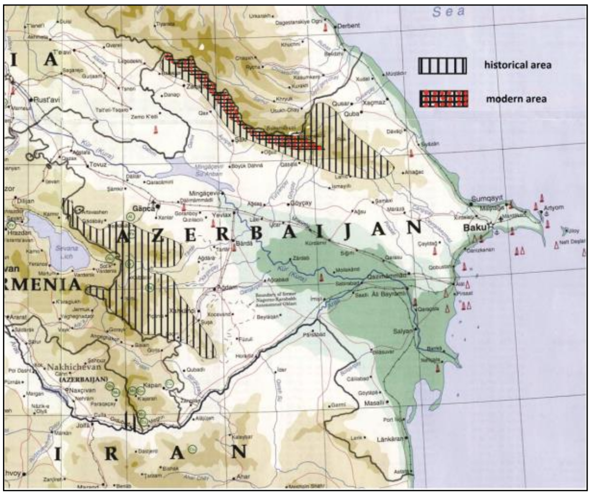


Fig. 3. The historical and modern habitat of the Caucasian Chamois in Azerbaijan (Guliyev, 2015)

Populations of Caucasian noble deer can be restored in the liberated Kalbajar, Lachin, Gubadli, and Zangilan regions. The modern range of Caucasian Chamois, (*Rupicapra rupicapra caucasica* L., 1758) populations is currently limited to the southern and northwestern slopes of the Greater Caucasus (Fig. 3).

According to Vereshagin's (1959) research, the historical range of this species also includes the Murovdagh and Shahdag ranges in the Lesser Caucasus.

They are found only in small numbers in the southern foothills of the Greater Caucasus Mountains in Azerbaijan (Guliyev, 1998a, 2007a, 2015). Caucasian Chamois are widespread in the mountainous and forested mountains, beginning in the western part of the Greater Caucasus and extending to the east. In time, they were found in large numbers in the coastal areas and river valleys of the upper reaches of the Katekhchay, Shinchay, and Turyanchay (Vereshagin, 1959).

By the end of the 19th century, this species is expected to be completely extinct in the Lesser Caucasus and in the upper reaches of the Zayam River (Vereshagin, 1942). At present, a small number of puppies have survived in these areas. The historical habitats inhabited by puppies in the territory of Azerbaijan have been suppressed due to changes in natural conditions and anthropogenic factors. The Caucasian Chamois remained in their historical habitats, only on the southern and northeastern slopes of the Greater Caucasus (Guliyev, 2015).

Asadov gives information about the area of the Caucasian Chamois in Azerbaijan and shows that this animal was in time in the Lesser Caucasus natural region of the republic in the late XIX and early XX centuries and that the Caucasian Chamois has already become extinct in that area (Asadov, 1960).

As it is known from literary sources, Caucasian Chamois lived in the natural regions of the Lesser Caucasus in the past. As it is known from literary sources, Caucasian Chamois lived in the natural regions of the Lesser Caucasus in the past. This roughly coincides with the Paleolithic period (Gadjiyev, 1977).

Now in the Lesser Caucasus, this animal is completely extinct (Guliyev, 2015). In the 30s of the XX century, Caucasian Chamois also existed in Karabakh, Shahdag range, and northwestern areas of Murovdag. Historical conditions have been created for the restoration of this species in the Murovdagh range. Animals can be obtained in the Zagatala reserve. The eastern foothills of the Murovdag range have the status of a strict protection regime by Goygol MP. Therefore, it is proposed to start a reintroduction project in the area first. Thus, it is possible to begin the restoration of the population of endangered mammal species mentioned in the recent past in the liberated areas

as soon as possible. Historical conditions have already been created for the reintroduction of these species to their historical habitats.

CONCLUSION

Due to the lack of accurate information about the existing fauna of Karabakh and surrounding areas, which have been under occupation for about 30 years, planned and long-term research should be started. Territories of liberated regions should be explored for gazelle (*Gazella subgutturosa* Guldenstaedt, 1778) in Aghdam, Fizuli, Jabrayil, Zangilan regions, Caucasian noble deer (*Cervus elaphus* Linnaeus) in Murovdag range.

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Qarabağ və işğaldan azad olunan ərazilərin faunası və bəzi iri məməli heyvanların reintroduksiyası perspektivləri

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Məqalədə mövcud ədəbiyyat məlumatları əsasında Qarbağ və işğaldan azad olunan ərazilərin faunası və bəzi iri məməli heyvanların tarixi areallarına reintrodukasiya məsələlərinə aydınlıq gətirilir. Ədəbiyyat məlumatları əsasında müəyyən edilmişdir ki, Qarabağ və işğaldan azad olunmuş ərazilərdə həşəratlar faunasının 56 növü nadir, endemik və nəsli kəsilmək təhlükəsində olan növlərdir. Kiçik Qafqazın Azərbaycan hissəsinin su hövzələrində təsadüf edilən 53 növ və yarımnöv balıqdan 7 növ Azərbaycanın “Qırmızı Kitab”ına (2013), 4 növ isə *İUSN*-in Qırmızı siyahısına daxil edilmişdir. Azərbaycanın batraxofaunasına aid 11 növ amfibilərdən 4-nə, herpetofaunasına aid 63 növ reptililərdən isə 35-nə bu ərazilərdə rast gəlinir. Azərbaycanın Kiçik Qafqaz və ona bitişik dağətəyi ərazilərində rast gəlinən amfibilərdən 1 növ IUCN-nin Qırmızı siyahısına, reptililərdən isə 6 növ IUCN-nin və Azərbaycanın “Qırmızı Kitab”ına (2013) daxil edilmişdir. Azərbaycanda işğala qədər mövcud olan 367 növ quşun (hazırda Azərbaycanın ornitofaunasını 407 quş növü təşkil edir) 200 növünə rast gəlinirdi. Hazırda Azərbaycan hüdudlarında 115 növ məməli növü qeydə alınmışdır. Qarabağ ərazisində işğala qədər 6 dəstəyə mənsub, 75 məməli növü qeydə alınmışdır. İşğala qədər 24 növ Azərbaycanın “Qırmızı Kitabı”na (2013) daxil edilmişdir. İşğaldan azad olmuş bölgələrdə yaxın keçmişdə nəsli kəsilmiş bir neçə iri məməli heyvan növünün bəzilərinin (Ceyran - *Gazella subgutturosa* Guldenstaedt, 1778, Qafqaz nəcib maralı - *Cervus elaphus* Ogilbu, 1870, köpgər - *Rupicapra rupicapra* Linnaeus, 1758) populyasiyasınının bərpasına ən qısa zamanda başlamaq mümkündür. İşğaldan azad olmuş Ağdam, Fizuli, Cəbrayıl, Zəngilan rayonlarının əraziləri bu məqsədlə tədqiq edilməli və mümkün yerlərdə ceyran, Kəlbəcər, Laçın, Qubadlı və Zəngilan rayonları ərazilərində Qafqaz nəcib maralının, Murovdağ silsiləsində köpgərin populyasiyalarının tarixi areallarına reintroduksiya edilməsi üçün artıq tarixi şərait yetişmişdir.

Açar sözlər: *Azərbaycan, Qarabağ, fauna, balıqlar, amfibilər, reptililər, quşlar, məməlilər, reintroduksiya, Qırmızı Kitab*

Животный мир Карабаха и территорий, освобожденных от оккупации и перспективы реинтродукции некоторых крупных млекопитающих

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В статье на основе доступной литературы вносится ясность в вопросах о фауне Карабаха и освобожденных территорий, а также реинтродукции в исторические местообитания некоторых крупных млекопитающих. Согласно литературным данным, 56 видов насекомых в Карабахе и на освобожденных территориях являются редкими, эндемичными и находящимися под угрозой исчезновения. Из 53 видов и подвидов рыб, обитающих в водоемах азербайджанской части Малого Кавказа, 7 видов занесены в Красную книгу Азербайджана (2013 г.), а 4 вида - в Красный список МСОП. На этих территориях также встречаются 4 из 11 видов земноводных, относящихся к батрахафауне и 35 из 63 видов рептилий, относящихся к герпетофауне Азербайджана. Из земноводных, обитающих на Малом Кавказе и прилегающих предгорьях Азербайджана, 1 вид внесен в Красный список МСОП. В

Красную книгу МСОП и Азербайджана внесены 6 видов рептилий (2013). До оккупации в Азербайджане орнитофауна была представлена 367 видами, число которых в настоящее время составляет 407, из них 200 видов обнаружены на исследуемой территории. На данный момент в Азербайджане отмечены 115 видов млекопитающих. До оккупации фауна Карабаха была представлена 75 видами млекопитающих, относящихся к 6 отрядам, из них 24 вида были занесены в «Красную книгу» Азербайджана (2013 г.). На освобожденных территориях можно начать восстановление популяции некоторых из недавно вымерших видов крупных млекопитающих (газель - *Gazella subgutturosa* Guldenstaedt, 1778, кавказский благородный олень - *Cervus elaphus* Ogilbu, 1870, серна - *Rupicapra rupicapra* Linnaeus, 1758). Для этого необходимо изучить освобожденные от оккупации территории Агдамского, Физулинского, Джебраильского и Зангиланского районов, по возможности, реинтродуцировать джейрана, газель и благородного оленя в исторические места их обитания – на территорию Кельбаджарского, Лачинского, Губадлинского и Зангиланского районов, а популяцию серны – на Муровдагский хребет, так как все объективные условия для этого уже есть.

Ключевые слова: *Азербайджан, Карабах, фауна, рыбы, амфибии, рептилии, птицы, млекопитающие, реинтродукция, Красная книга*

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Taxonomic structure and ecological analysis of plant cover of the alpine-subalpine landscapes of the Karabakh natural subregion (Lesser Caucasus)

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The orographic elements, vegetation cover of the alpine-subalpine zone, its taxonomic structure, and endemism of the Karabakh natural subregion were investigated. A total of 608 plant species (14% of Azerbaijan flora) belonging to 65 families and 253 genera are identified in the region. Of them, 353 species are wide areal plants, 255 are endemic species with different distribution statuses. *Asteraceae* (79), *Poaceae* (41), *Lamiaceae* (32), *Fabaceae* (31), *Rosaceae* (30), *Caryophyllaceae* (28), *Ranunculaceae (23), Brassicaceae (21), Apiaceae (25)* found in the region are dominant families. The 18 genera found in the area are sensitive and are represented by only one species in the flora of the region. *Asteraceae (67), Fabaceae (18), Apiaceae (18), Caryophyllaceae (17), Lamiaceae (14), Ranunculaceae (14), Brassicaceae (21)* are dominant endemic families. Among the endemic species, 13 are local endemic species native to Transcaucasus.

Keywords: *Karabakh natural subregion, biodiversity, alpine-subalpine landscapes, endemism, sensitive species*

INTRODUCTION

The study of the alpine and subalpine vegetation has a foundational role in ecology. Because, alpine-subalpine plants grow in harsh climatic conditions (low temperatures, prolonged frost, heavy snow accumulation, ultraviolet radiation, poor nutrition, wind), limit the vegetative period. These factors influence the plant population size. These data allow us to assess the climate change impacts on the population.

Located within the Caucasus Ecoregion, Karabakh natural subregion is considered an important area, due to its biodiversity, especially plant species. The region is known for its high endemism, and unfortunately, some of the plant species are at the edge of extinction due to afforestation, fires, excessive grazing, hybridization, and climate changes.

MATERIALS AND METHODS

Alpine and subalpine vegetation of the Karabakh natural subregion and their temporal changes are rarely studied and are concerns only some taxons (Hacıyev, 2004; Ibadullayeva et al., 2015; Əskərov, 2016; Aslanova, 2018). The main researches in this region were performed 30 years ago due to the occupation of these territories by the Armed Forces of Armenia. Therefore, our studies were carried out on plant diversity in other territories of the region – in high-mountains slopes of the Shahdagh, Shakarbeyli, Garaarkhaj, Garadag, Chanliyal ranges, and Goshgardag, Kapaz mountains. In assessing of biodiversity dynamics and status of the territory, used also the data of the last 70 years (Гроссгейм, 1955; Комаров, 1960). We also used data from online atlases and plant guides, such as Plantarium, Royal Botanic Gardens, World Plants, The Plant List, etc.

RESULTS AND DISCUSSION

The Karabakh natural subregion is located in the West part of Azerbaijan and in the South-West part of the Lesser Caucasus. The region consists of some orographic units such as Shahdag Range, Gokche Range, Karabagh volcanic Plateau,

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Karabakh Range, and some of the little ranges toward the different sites (Fig. 1). The subalpine landscapes in the Karabakh natural subregion are represented from the elevation of 1700-1800 m a.s.l to 2300-2400 m a.s.l. The alpine landscapes lie from 3200 m a.s.l. to 3500 m a.s.l. (Мусеибов, 2003; Məmmədov, 2015). The lower and upper boundaries of these landscapes and their transition depends on their altitude features and location. The transition from subalpine to alpine landscape is accompanied by ecotones – transition zones, where sparse and small trees and tall grasslands are replaced by low-statured, non-arboreal, and densely packed vegetation.

As seen in Fig.1 the Karabakh natural subregion is divided into 5 parts: 1. Shahdag Range and lateral ranges (Shakarbeyli, Garaarkhaj, Garadag, Chanliyal ranges and etc.); 2. Gokche Range; 3. Karabakh Range and lateral ranges (Ziyarat, Baghirkhan, Girkhgiz ranges, etc.); 4. Murov Ranges and lateral ranges (Gaflan-Gala, Bulagdagh, Goshgar, Pant, Gara Gaya ranges, etc.); 5. Karabakh Plateau and lateral ranges (Saribulagdag, Hochaz, Mikhtokan, Uzunyal, Eshek meydani, Chil Gaya, Khojayurd, etc.). Each of these parts has specific features of biodiversity.

The soils that are found in the alpine and subalpine belt of Karabakh natural subregion are mountain-meadow primitive, residually carbonate mountain-meadow, field mountain-meadow and mountain-meadow peat soils (Məmmədov, 2014).

The region also has a reach landscape diversity. Within this territory, there are two types of landscapes: high-mountain subalpine forest-shrub-meadow landscapes and high-mountain alpine shrub-meadow landscapes and 18 landscape species (Məmmədov, 2015; Əlizadə, 2017).



Fig. 1. Relief map of the Karabakh natural subregion

The plant taxonomy of Alpine and Subalpine vegetation of the Karabakh natural subregion is shown in Table 1.

According to the number of species leading families of Karabakh flora are: *Asteraceae* (79), *Lamiaceae* (32), *Rosaceae* (29), *Fabaceae* (29), *Caryophyllaceae* (28), *Ranunculaceae* (23), *Brassicaceae* (21), and *Apiaceae* (20) (Table 2). There are 25 dominant genera of alpine-subalpine landscapes in the region (Table 3). As seen from the Table *Campanula (Campanulaceae;* 25*), Carex (Cyperaceae;* 20*), Veronica (Plantaginaceae;* 16*), Senecio (Asteraceae;* 15*), Silene (Caryophyllaceae;* 15*)* are dominant plant families.

Table 1. Plant taxonomy of Alpine and Subalpine vegetation of the Karabakh natural subregion.

№	Class	Families, n		Genera, n		Species, n	
		Region	Flora	Region	Flora	Region	Flora
1.	*Lycopodiopsida*	1	2	1	2	1	2
2.	*Polypodiopsida*	4	6	9	24	11	55
3.	*Gnetopsida*	1	1	1	1	1	6
4.	*Pinopsida*	2	3	1	3	3	16
5.	*Liliopsida*	11	25	38	213	123	958
6.	*Magnoliopsida*	46	95	203	771	469	3351
Total:		**65**	**133**	**253**	**1015**	**608**	**4388**

There are 23 sensitive plant families represented by the only genera and species in the alpine-subalpine vegetation of the region (Table 4).

Table 2. Dominated families and its structure of alpine-subalpine flora of the Karabakh natural subregion.

№	Families	Genera, n		Spesies, n	
		in region	in flora	in region	in flora
	Polypodiopsida (11 species)				
1.	*Aspleniaceae*	5	10	7	21
	Liliopsida (113 species)				
1.	*Poaceae*	13	113	41	469
2.	*Cyperaceae*	5	19	17	116
3.	*Asparagaceae*	6	14	16	55
4.	*Orchidaceae*	4	20	12	62
5.	*Amaryllidaceae*	2	4	11	51
6.	*Liliaceae*	3	4	6	55
	Magnoliopsida (463 species)				
7.	*Asteraceae*	41	121	79	572
8.	*Lamiaceae*	14	37	32	219
9.	*Fabaceae*	10	43	31	293
10.	*Rosaceae*	11	33	30	216
11.	*Caryophyllaceae*	11	34	28	191
12.	*Ranunculaceae*	12	23	23	101
13.	*Brassicaceae*	14	82	21	245
14.	*Apiaceae*	11	70	20	182
15.	*Orobanchaceae*	6	16	18	73
16.	*Campanulaceae*	1	7	15	58
17.	*Plantaginaceae*	5	12	16	101
18.	*Gentianaceae*	4	6	10	22
19.	*Primulaceae*	3	8	10	27

Endemism of the territory. The number of endemic species in the flora of any area is an indicator of the specificity and uniqueness of the vegetation of that area. In the Caucasian flora described 1600 endemic plant species belonging to 13 endemic genera, which is about 25% of the total flora (Муртазалиев, 2012). Most of these species occur in high mountainous landscapes (Татанов, 2013; Shulkina et al., 2014; Zazanashvili et al., 2000).

Table 3. Distribution of the alpine-subalpine genera/species of the region.

№	Genera	Families	Number of species		
			in the flora	in the region	%
		Liliopsida			
1.	*Carex*	*Cyperaceae*	116	12	10
2.	*Allium*	*Amaryllidaceae*	51	8	12
3.	*Ornitho-galum*	*Asparagaceae*	55	8	9
4.	*Iris*	*Iridaceae*	36	6	17
5.	*Alopecurus*	*Poaceae*	469	6	1
6.	*Poa*	*Poaceae*	469	6	1
7.	*Gagea*	*Liliaceae*	55	5	9
		Magnoliopsida			
8.	*Campanula*	*Campanulaceae*	60	15	25
9.	*Hieracium*	*Asteraceae*	572	11	2
10.	*Nepeta*	*Lamiaceae*	222	10	5
11.	*Veronica*	*Plantoginaceae*	101	10	10
12.	*Alchemilla*	*Rocaceae*	216	10	5
13.	*Saxifraga*	*Saxifragaceae*	14	9	64
14.	*Trifolium*	*Fabaceae*	293	9	3
15.	*Pyrethrum*	*Asteraceae*	572	8	1
16.	*Senecio*	*Asteraceae*	572	8	1
17.	*Ranunculus*	*Ranunculaceae*	101	7	7
18.	*Gentiana*	*Gentianaceae*	22	7	32
19.	*Psephellus*	*Asteraceae*	572	7	1
20.	*Heracleum*	*Apiaceae*	183	6	3
21.	*Anthemis*	*Asteraceae*	572	6	1
22.	*Tragopogon*	*Asteraceae*	572	6	1
23.	*Jurinea*	*Asteraceae*	572	5	1
24.	*Vicia*	*Fabaceae*	293	5	2
25.	*Thymus*	*Lamiaceae*	222	5	2

Table 4. Sensitive plant families represented in the region.

	Families	Family taxons			Status
		Genera	Species		
			Name	n	
1	**2**	**3**	**4**	**5**	**6**
			Lycopodiopsida		
1.	*Selaginellaceae*	*Selaginella*	*S.helvetica*	1	Widespread
			Polypodiopsida		
2.	*Alismataceae*	*Alisma*	*A. plantago – aquatica*	5	Widespread
3.	*Ophioglossaceae*	*Botrychium*	*B. lunaria*	4	Widespread
			Gnetopsida		
4.	*Ephedraceae*	*Ephedra*	*E.procera*	5	Widespread
			Pinopsida		
5.	*Taxaceae*	*Taxus*	*T.baccata*	1	Widespread

Table 4 continued

1	**2**	**3**	**4**	**5**	**6**
			Liliopsida		
6.	*Colchicaceae*	*Colchicum*	*C. speciosum*	11	Subendemic
7.	*Melanthiaceae*	*Veratrum*	*V. lobelianum*	2	Widespread
			Magnoliopsida		
8.	*Aceraceae*	*Acer*	*A. trautvetteri*	8	Subendemic
9.	*Fagaceae*	*Quercus*	*Q. macranthera*	9	Subendemic
10.	*Grossulariaceae*	*Ribes*	*R.orientale*	4	Widespread
11.	*Polygalaceae*	*Polygala*	*P. alpicola*	9	Caucasian endemic
12.	*Salicaceae*	*Salix*	*S. caucasica*	16	Subendemic
13.	*Celastreaceae*	*Parnassia*	*P. palustris*	6	Widespread
14.	*Ceratophyllaceae*	*Ceratophyllum*	*C. demersum*	2	Widespread
15.	*Oxalidaceae*	*Oxalis*	*O. acetosella*	3	Widespread
16.	*Solanaceae*	*Solanum*	*S. persicum*	18	Widespread
17.	*Urticaceae*	*Urtica*	*U.dioica*	7	Widespread
18.	*Viburnaceae*	*Viburnum*	*V. lantana*	4	Widespread

n – number of species in the flora of Azerbaijan



Fig. 2. Characteristic plants of the alpine-subalpine flora of the Karabakh natural subregion:
Upper left: *Astrantia trifida* (Transcaucasica)
Upper right: *Campanula sibirica* (Wide areal)
Down left: *Linum hypericifolium* (North Caucasus, Transcaucasus, Turkey)
Down right: *Senecio sosnowskyi* (North Caucasus, Transcaucasus).

Table 5. Dominant plant families and their characteristics.

№	Families	In the flora, n	In landscapes			
			Total, n	Endems, n	%	Endemism, %
	Liliopsida					
1.	*Amaryllidaceae*	51	9	8	89	16
2.	*Poaceae*	469	33	7	21	1
3.	*Asparagaceae*	55	9	7	78	13
4.	*Iridaceae*	36	9	7	78	19
5.	*Liliaceae*	56	7	6	86	11
6.	*Orchidaceae*	62	12	4	33	6
	Magnoliopsida					
1.	*Asteraceae*	573	114	67	59	12
2.	*Fabaceae*	293	31	18	58	6
3.	*Apiaceae*	183	20	18	90	10
4.	*Caryophyllaceae*	191	27	17	63	9
5.	*Rosaceae*	216	30	15	50	6
6.	*Lamiaceae*	222	32	14	44	6
7.	*Ranunculaceae*	101	23	14	61	14
8.	*Brassicaceae*	245	22	10	45	4
9.	*Orobanchaceae*	73	18	8	44	11
10.	*Campanulaceae*	60	15	9	60	15
11.	*Plantaginaceae*	101	15	7	47	7

There are 296 endemic species with different distribution statuses in alpine-subalpine vegetation of the Karabakh Natural Subregion (Table 5). Of them 41 species in 8 families belong to *Liliopsid*a. Therefore, the originality of plant diversity of the region is about 7% of the total flora and about 50% of the landscape flora.

These species have different geographical areas and habitats. Some of them cover the entire Caucasus Ecoregion (North Caucasus, Transcaucasus, Turkey and Iran). The second group of species is widespread only in the North and South Caucasus. The third group of species is distributed in the same landscapes of the North Caucasus, Transcaucasus and Turkey. Finally, the fourth group of endemic species are found in the alpine-subalpine landscapes of the North Caucasus, Transcaucasus and Iran territories (Fig. 3, Table 6, Table 7).

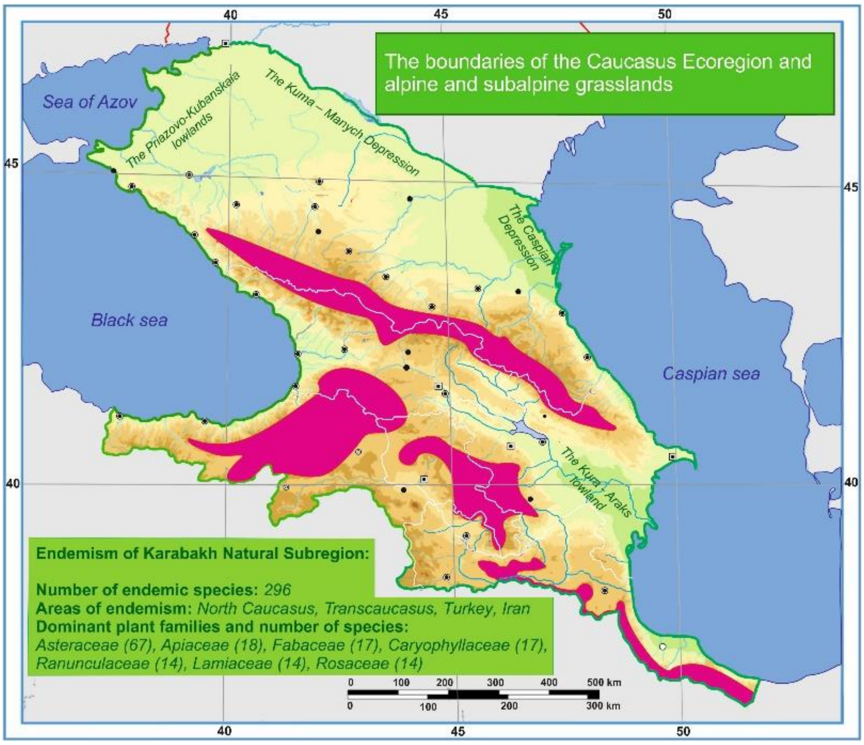


Fig. 3. Boundary of Caucasus Ecoregion and distribution of endemic plant species of the Karabakh Natural Subregion

Table 6. Distribution of dominant endemic families of Karabakh Natural Subregion within Caucasus Ecoregion.

Distribution of endemic species	Total number of species in the region	Number of endemic species in the families									
		Asteraceae	Apiaceae	Caryophyllaceae	Fabaceae	Ranunculaceae	Lamiaceae	Rosaceae	Brassicaceae	Campanulaceae	Orobanchaceae
North Caucasus, Transcaucasus	68	23	3	5	7	1	4	3	3	1	2
North Caucasus, Transcaucasus, Turkey	97	18	3	6	4	3	3	6	6	4	5
North Caucasus, Transcaucasus, Iran, Turkey	83	10	7	5	5	8	5	3	-	2	1
Transcaucasus	29	11	4	1	1	-	2	2	1	-	-
North Caucasus, Transcaucasus, Iran	19	5	1	-	1	2	-	1	-	2	-
Total	296	67	18	17	17	14	14	14	10	9	8

Table 7. Regional endemic (native to the Transcaucasus) plants occurring in the Karabakh Natural Subregion.

№	Families	Species
		Liliopsida
1.	*Iridaceae (3)*	*Iris caucasica* var. *multiflora, I.grossheimii, I.winogradowii*
		Magnoliopsida
2.	*Apiaceae (4)*	*Astrantia trifida, Carum komarovii (Aegopodium komarovii), Heracleum schelkovnikowii, H.albovii*
3.	*Asteraceae (11)*	*Echinops pungens (E.szowitsii), Hieracium karjaginii (H.levicaule* supsp. *karjaginii), Jurinea blanda, J.grossheimii, J. praetermissa, J.spectabilis, Lactuca kirpicznikovii, Psephellus karabaghensis, P. transcaucasicus, P.komarovii (Tanacetum zangezuricum), Scorzonera kirpicznikovii*
4.	*Brassicaceae (1)*	*Alyssum globosum (Takhtajaniella globosa)*
5.	*Caprifoliaceae (1)*	*Cephalaria armeniaca*
6.	*Caryophyllaceae (1)*	*Silene depressa*
7.	*Fabaceae (1)*	*Lathyrus ciliatidentatus*
8.	*Lamiaceae (2)*	*Ajuga oblongata, Scutellaria sevanensis*
9.	*Linaceae (1)*	*Linum subbiflorum*
10.	*Papavearceae (1)*	*Papaver zangesurum*
11.	*Plantaginaceae (1)*	*Linaria schelkownikowii (L.grossheimii)*
12.	*Rosaceae (2)*	*Alchemilla epipsila, Rosa isaevii*
13.	*Thymelaceae (1)*	*Daphne axilliflora*

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Qarabağ Təbii Yarımvilayətinin subalp-alp landşaftlarının bitki örtüyünün taksonomik strukturu və ekoloji analızı (Kiçik Qafqaz Təbii Vilayəti daxilində)

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Qarabağ təbii yarımvilayətinin oroqrafik elementləri, ərazinin alp-subalp landşaftlarının bitki müxtəlifliyi, taksonomik strukturu, endemizmi araşdırılmışdır. Ərazidə 65 fəsilə, 253 cinsə aid 608 bitki növü müəyyən edilmişdir. Azərbaycan florasının 14%-ni təşkil edən bu növlərdən 312 növ geniş areallı, 296 növ isə müxtəlif statuslu endem növlərdir. Fəsilələr arasında *Asteraceae* (79), *Poaceae* (41), *Lamiaceae* (32), *Fabaceae* (31), *Rosaceae* (30), *Caryophyllaceae* (28), *Ranunculaceae (23), Brassicaceae (21), Apiaceae (25)* fəsilələri dominant fəsilələrdir. Ərazidə rast gəlinən 18 fəsilə həssas fəsilələr olub region florasında yalnız 1 növ ilə təmsil olunur. *Asteraceae (67), Fabaceae (18), Apiaceae (18), Caryophyllaceae (17), Lamiaceae (14), Ranunculaceae (14), Brassicaceae (21)* endem növlərin sayına görə dominant fəsilələrdir. Endem növlərdən 13 növ regional endem növ olub Cənubi Qafqaz endemləridir. Burada *Asteraceae (11), Apiaceae (4) və Iridaceae (3)* fəsilələri üstünlük təşkil edir.

Açar sözlər: *Qarabağ təbii subregionu, bioloji müxtəliflik, flora, alp, subalp, endemizm, həssas növlər*

Таксономическая структура и экологический анализ растительности альпийско-субальпийских ландшафтов Карабахской Природной Области (Малый Кавказ)

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Изучены орографические элементы, видовой состав, таксономическая структура, эндемизм растений альпийско-субальпийских ландшафтов Карабахской природной области. На территории выявлены 608 видов растений, относящихся к 65 семействам и 253 родам. Из этих видов, которые составляют 14% флоры Азербайджана, 312 являются широкоареальными видами, а 296 - эндемичные виды с различным статусом. Семейства *Asteraceae* (79), *Poaceae* (41), *Lamiaceae* (32), *Fabaceae* (31), *Rosaceae* (30), *Caryophyllaceae* (28), *Ranunculaceae* (23), *Brassicaceae* (21), *Apiaceae* (25) являются доминантными. Среди семейств, встречающихся в регионе, 18 являются чувствительными семействами и представлены единственным видом. *Asteraceae* (67), *Fabaceae* (18), *Apiaceae* (18), *Caryophyllaceae* (17), *Lamiaceae* (14), *Ranunculaceae* (14), *Brassicaceae* (21) являются доминирующими эндемичными семействами. Из эндемичных видов встречающиеся в регионе 13 видов являются региональными эндемиками т.е. эндемиками Южного Кавказа. Среди них *Asteraceae* (11), *Apiaceae* (4) и *Iridaceae* (3) доминируют.

Ключевые слова: *Карабахская природная область, биологическое разнообразие, флора, альпийский, субальпийский, эндемизм, чувствительные виды*

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The importance of mycological research and directions of future research in the liberated territories of Azerbaijan

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The presented work substantiates the importance of mycological assessment of the current ecological situation in the liberated territories of Azerbaijan and its implementation due to changes caused by both the occupation factor and global problems on the planet. The assessment of a specific biotope would be incomplete without studying the fungi that are actively involved in all the ecological functions that occur in nature. Therefore, the implementation of research in accordance with the priority areas of the world is important both from a scientific and practical point of view and will allow the realization of the probability of achieving interesting results.

Keywords**:** *Occupied territories, natural resources, bioresources, fungi, biologically active substances, phytopathogenic fungi*

INTRODUCTION

The state of natural resources used in various areas (industry, agriculture and household), first of all, quality indicators are determined by various criteria, one of them and the most important is related to biotic factors. Since this indicator covers all taxonomic groups of living things on Earth, it is a matter of special attention and worries everyone. Despite the fact that the quality of resources depends on humans, every year a large group of living things, as well as humans, get sick and even die due to biological contamination of resources used(food, feed, medical, technical, etc.) for various purposes (Ucar et al., 2016). For this reason, identification, forecasting and management of biological pollution of resources is one of the current areas of research widely conducted in the world today(Altenburger et al., 2019; Tran et al., 2020).

The liberated territories of the Karabakh region as a result of the 44-day counter-offensive of our victorious army under the leadership of the President of the Republic of Azerbaijan, Supreme Commander-in-Chief Ilham Aliyev are of greater importance against the background of the above-mentioned tasks. This is confirmed by the following:

First, the territories of Azerbaijan occupied since 1988 with the help of the patrons of the Republic of Armenia, are rich and colorful in nature (https://files.preslib.az/projects/azereco/ru/eco_m2_6.pdf). Thus, there are more than 2000 plant species, in the plain places such as wormwood, wormwood-saline semi-border, steppe and semi-steppe vegetation in the foothills, shrubs on mountain slopes, deciduous forests cover a large area. Subalpine and alpine meadows are at an altitude of 2000-2300 m above sea level. Due to all forms of crop production, the wide diversity of flora and fauna, diversity of natural resources and large reserves, it was not only lagging behind other territories of Azerbaijan but in some respects was characterized by superior performance. The number of sunny days a year is 2000-2400 hours there. Soil types are also characterized by a wide variety, and here are found chestnut, light chestnut, brown mountain-forest, brown mountain forest, dark mountain-meadow and other soil types (https://www.virtualkarabakh.az/az/post-item/26/45/qarabag-tebieti.html). These areas are also characterized as areas of distribution of animal and plant species included in the "Red Book of Azerbaijan" (2013).

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Secondly, due to the occupation, scientific research was not carried out by the Institutions of the Republic of Azerbaijan. If the study was carried out, it covered a certain part of the occupied territories. For example, in 1986, I and Ph.D. H.E.Kanigina, an employee of the Institute of Botany of ANAS, began to conduct field mycological studies in the forests of the Kelbajar and Lachin regions, but we could not bring these studies to a definite result, since then those territories have been closed for such studies. It should be added that even during the Soviet era, there were special difficulties in clarifying a number of issues in the Daglig Karabakh (in the territory of the former Daglig Karabakh Autonomous Region). In short, the liberated territories are characterized as hardly studied areas for the Azerbaijani scientific community for about a century.

Third, the occurrence of specific anthropogenic pollution as a result of military operations in the territories, large and small-scale military conflicts, and depending on its character in nature, primarily in the bioresources of the area creates specific changes. Sufficient research material (Linden et al., 2004; Rueveny et al., 2010) confirms that changes in these types of effects are often negative.

Fourth, it is a form of the attitude of the occupiers towards the territories. Thus, the occupation is to give preference to approaches to the natural resources of these areas, which are difficult for the human mind to understand, and which, without exaggeration, can be called both biological and environmental terrorism. The aggravation of the situation was aggravated by the fact that the Republic of Armenia didn't accede to international conventions on the protection and efficient use of natural resources, as well as military conflicts (for example, related to transboundary waters). The results of preliminary research conducted by various governments (Ministry of Ecology and Natural Resources) (https://sputnik.az/20201023/azerbaycanin-bitki-ortuyunun-qirx-iki-425274032.html) and scientific institutions (Institute of Microbiology, Soil Science and Agrochemistry of ANAS) of the Republic of Azerbaijan prove it today. Thus the analysis of samples taken from the water, soil and plant of the liberated territories, it observed the negative effects on both nature and human health. For example, in our researches at the Institute of Microbiology of ANAS, in some rivers of the liberated territories in the Fizuli region, the amount of heavy metals exceeded the permissible concentration, the number of microbiota and moisture decreased, the background toxicity increased, etc. confirmed. In addition, the field observations of the Institute's staff in Shusha and in the Lachin corridor, as well as the initial laboratory analysis of water and soil samples taken from there, gave serious grounds to say that the occupation factor had a significant impact on the area and that these facts were negative.

Finally, as a result of increasing anthropogenic impacts on the environment, global problems (desertification, climate change, biodiversity degradation, salinization, etc.) are emerging and increasingly affecting all parts of the world to one degree or another (McMichael et al., 2008). This, in turn, has made it necessary to re-evaluate the natural resources, including bioresources of the areas studied extensively some time ago (20-30 years ago) in response to changing conditions. Because bioresources are more sensitive to both pollution and the effects of pollution. Thus, the interactions between plants, animals, fungi, and other living things that make up biodiversity determine the state of an ecosystem, and therefore any factor that causes them to change at the same time causes the ecosystem to change as a whole (Fisher et al., 2006). In order to restore the status quo of the occupied territories in accordance with today's realities and to prepare a scientific basis for its effective use, it is necessary to study all the creatures that have settled there and are potentially bioresources. Thus, one of the main problems of modern biological science, as well as various fields (botany, zoology, mycology, etc.) is the development of scientific and practical bases for the protection of biodiversity on earth and their use in accordance with the principles of sustainable development. To this end, research such as the complex relationships between the individual components of any ecosystem and their functional significance, as well as a comprehensive study of the development dynamics, interactions and productivity of various biocomponents in the ecosystem (Perotto et al., 2013) are important.

It should be noted that while the number of eukaryotic organisms (plants, animals and fungi) on Earth is now known to be more than 2 million, the number of actual worlds in nature is much higher. For example, the number of eukaryotic species on Earth is estimated to be 8.7 million (Mora et al., 2011).

It should be noted that fungi, which are important components of the heterotrophic block of any ecosystem where bioresources are important and contain organic matter, lag behind both animals and plants in terms of the number of species. Thus, according to classical approaches, the number of species of fungi identified for science is now equal to 100 thousand, which is several times less than the species of plants and animals known to science. Nevertheless, fungi are actively involved in all environmental functions (production, destruction, identification and regulation) that occur in nature (Schmit and Mueller, 2007) Thus, on the one hand, fungi that are actively involved in the pollution of resources and regulation of species composition of biodiversity, on the other hand, the mineralization of organic matter (Arefyev, 2010) with soil and water, as well as various metabolites they also take an active part in enrichment. Among these metabolites are those that are useful in terms of both practical needs (various polysaccharides with functional activity, surface acids, photohormones, etc.) (Bakhshaliyeva et al., 2020; Frljak et al., 2021; Hoeksma et al., 2019) but also dangerous to human health (mycotoxins) (Greef-Laubscher et al., 2020) It is no coincidence that mushrooms are considered to be figuratively disrupting harmony in nature, confusing researches and descendants of the devil, and are now considered a major threat to food security in the world (Hyde et al., 2018). Therefore, without these studies, research aimed at assessing any ecosystem cannot be considered comprehensive. Therefore, attention should be paid to research in the liberated areas, and fungi should be one of the most widely studied organisms.

It would be appropriate to touch on the issue of fungi, which is related to the number of species of fungi. As mentioned, there is a difference between the actual number of living things on Earth and the number of species of living things known to science, and this difference is for the benefit of nature. The idea that the number of fungal species assigned to classical approaches (based on cultural-morphological and physiological characteristics) is 7-8% of those that exist in nature no longer reflects reality, and the number of species of fungi that exist in nature 1.2-1. Not 5 million (Hawksworth, 2004), not 3.5-5.1 million (Blackwell, 2011), 12 million according to molecular phylogenetic approaches (Wu et al., 2019), and this figure will be one in the future is likely to rise as much.

At present, the study of fungi is carried out in several aspects, and if we summarize the research conducted in connection with their study, it is clear that the research conducted in connection with their study is devoted to solving the following tasks:

Determination of the species composition of fungi as one of the important components of biodiversity on Earth based on modern molecular genetic methods;

Search for active producers of biologically active substances, including various substances with pharmacological activity, selection of active producer and determination of the effect of the obtained substances, the field of application, development of production technology;

Diseases caused by fungi, development of methods for their prevention and identification of opportunities for the use of fungi in biological control;

The use of fungi as strain – producers, which allows making non – traditional substrates suitable for practical use by biological conversion, obtaining biomass energy, etc.

According to the above, if we try to assess the liberated territories, we must first note that, in general, the first mycological studies in Azerbaijan were conducted in these liberated territories (quoted from Akhyndov et al., 2008), which coincided with the 4th quarter of the XIX century. This is one of the new facts that will be noted in a positive light in terms of mycological assessment of the liberated territories of the Karabakh region, which today is important only in terms of the history of mycological research. The cases of timely collection and herbarium samples collected from these areas (for example, in the Institute of Botany of ANAS) can be considered as positively evaluated, but they are also the most historically important at the present stage of development of mycology.

CONCLUSIONS

Thus, for the above reasons, recalling that no systematic mycological research was carried out even before the occupation and that all living and non-living components of the area changed as a result of both occupation and natural processes, these areas are now open for mycological research. It is safe to say that it is an interesting object. At the

same time, if we take into account that the natural soil, climate, flora and fauna on the region are in a sense specific, the quantitative indicators of the producer of one or another feature are so variable at the strain level, then at least 30 years of full scientific research there will be no doubt that interesting results will be obtained both from a scientific and practical point of view in a remote and diverse area. Therefore, it is necessary to conduct mycological research in the liberated territories, to assess the current ecological condition of the liberated territories, restoration and efficient use of resources, as well as to scientifically assess the potential of biodiversity inherent in the nature of Azerbaijan is the issue.

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Azərbaycanın işğaldan azad olunmuş ərazilərində mikoloji tədqiqatların aparılmasının zəruriliyi və gələcək tədqiqat istiqamətləri

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Təqdim olunan işdə Azərbaycanın işğaldan azad olunmuş ərazilərinin müasir ekoloji vəziyyətinin mikoloji cəhətdən qiymətləndirilməsinin vacib olması və bunun həm işğal faktorundan irəli gələn, həm də planetdə baş verən qlobal xarakterli problemlərdən yaranan dəyişikliklərə görə həyata keçirilməsi əsaslandırılır. Təbiətdə baş verən bütün ekoloji funksiyalarının hamısında aktiv şəkildə iştirak edən göbələkləri tədqiq etmədən konkret bir biotpun ekoloji vəziyətinin qiymətləndirilməsinin yarımçıq olmasına səbəb olması və bu səbəbdən də tədqiqatların dünyada aprılanların piroritet istiqamətlərə müvafiq aparılması həm elmi, həm də praktiki baxımdan əhəmiyyət kəsb edən nəticələrin əldə edilməsini zəruriləşdirəcəkdir.

Açar sözlər: *İşğal olunmuş ərazilər, təbii ehtiyatlar, bioresurslar, göbələklər, bioloji aktiv maddələr, fitopatogen göbələklər*

Важность микологических исследований и направления будущих исследований на освобожденных территориях Азербайджана

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В представленной работе обосновывается важность микологической оценки современной эко-логической ситуации на освобожденных территориях Азербайджана и её реализации в связи с изменениями, вызванными как оккупационным фактором, так и глобальными проблемами на планете. Без исследования грибов, которые активно задействованы во всех экологических функциях природы, оценка экологического состояния того или иного биотопа является неполной, и поэтому проведение исследований, согласно приоритетным направлениям в мире, сделает необходимым получение как научно-, так и практически значимых результатов.

Ключевые слова: *Оккупированные территории, природные ресурсы, биоресурсы, грибы, биологически активные вещества, фитопатогенные грибы*

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Mapping of LC/LU changes inside the Aghdam district of the Karabakh economics region applying object-based satellite image analysis

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Identification of the environmental consequences of the 30-year occupation of Karabakh and its adjacent territories by the Armenian armed formations is an important and urgent research task. Object-Based Image Analysis (OBIA) procedures were accordingly applied to examine the condition and changes in landcover and landuse (LC/LU) in the territories of Karabakh liberated from Armenian occupation within the Aghdam District. Firstly, Dynamic Thresholds Indexing (DTI) algorithms were operated to display the main LC by developing several spectral NDWI, NDVI, NBRI, and AVBI indices. At the next step, to recognize precise LU changes inside the study area, a rule-based Nearest Neighbour Classify (NNC) was considered by accompanying an advanced supervised classification technique within the Trimble eCognition setting (eCognition Developer, 2019). DTI results indicated that from 2016 to 2021 inside the Aghdam District, LC changes are quite meaningful. A significant decrease in vegetated cover (10.2 %), increases in the non-vegetated area (11.8 %), and the most noticeable changes are observed in vulnerable lands of about 45.1 km^2 (26.8 %). Subsequently, the rule-based NNC method approved various negative LU changes inside the study area that had occurred predominantly to the mixed forest-pasture classes (9.8 %). Besides, the areas of degraded lands have increased by 35 % and barren lands by 4.4 % according to the study. It should be noted that water and agricultural LU demonstrate the least changes overall of 3.4 % and 0.3 %, respectively. The overall accuracy of 0.95 and Kappa statistics of 0.93 confirmed the significant changes in the final LC/LU productions. Consequently, accurate image processing and mapping of the current situation of the liberated regions of Azerbaijan have to be the most urgent tasks of the geographers, ecosystem scientists, and remote sensing specialists prior to the start of reconstruction and rehabilitation projects by government officials and decision-makers.

Keywords: *Aghdam district, Karabakh region, LC/LU changes, sentinel-2 imagery, OBIA-based dynamic and threshold indexing, NNC supervised classification*

INTRODUCTION

Occupying the territory of neighboring countries can have serious catastrophic social, economic, and, of course, geographical, and ecological consequences (General Assembly Security Council, 2009). One of the vital consequences of the occupation of the Karabakh districts by Armenia had had significant changes in LC/LU types; and other environmental features of the region (Scheffer, 2010). Although the terms land cover and land use are often used interchangeably, their actual meanings are quite distinct. LC refers to the surface cover on the ground, whether vegetation, urban infrastructure, water, bare soil, or others.

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Identifying, delineating, and mapping LC is important for large-scale monitoring studies, resource management, and planning activities. Identification of LC establishes the baseline from which monitoring activities (change detection) can be performed and provides the ground cover information for baseline thematic maps. Nevertheless, LU refers to the purpose the land serves, for example, recreation, wildlife habitat, or agriculture. LU applications involve both baseline mapping and subsequent monitoring, since timely information is required to know what current quantity of land is in what type of use and to identify the LU changes from year to year (Rasouli et al., 2021a). This knowledge will help develop strategies to balance conservation, conflicting uses, and developmental pressures. Issues driving LU studies include the removal or disturbance of productive land, urban encroachment, and depletion of grasslands and forests. Accordingly, it is very important to distinguish this difference between LC and LU, and the timely updated information that can be ascertained from each. The properties measured with remote sensing imagery relate to LC, from which LU can be inferred, particularly with a priori knowledge obtained by advanced image processing techniques (Kato, 2020).

With high confidence, we believe that the fundamental driving force of LC/LU changes in the Karabakh Economics Region is related to temporal-spatial processes caused by war activities such as the compulsory seizure of agricultural and livestock activities, along with the destruction of rare forests (Hasanov et al., 2017). Moreover, we should consider the uncontrolled erosion of soil, pasture, and unique historical monument buildings destruction caused by unprincipled mining activities, multiple bombings, and land-mine landings within the occupied territories of Azerbaijan (Conflict and Environment Observatory, 2021). Remote sensing makes it possible to collect data by sensing and recording reflected or emitted energy and processing, analyzing, and production of a variety of practical information in various fields (Lillesand et al., 2004). Through this modern technology, large amounts of row data and information in the form of digital satellite images are prepared and made available to researchers (Khandelwal et al., 2014a; Copernicus, Sentinel-2, 2020). Up to now, many different methods have been developed in the processing data obtained from remote sensing technology, each with its advantages and limitations. To detect the LC/LU situations over time, advanced OBIA methods could be applied to analyze post-war changes, focusing on the interesting areas. To date, several methods have been proposed in the process of producing LC/LU maps through satellite image processing, as it could be regarded as the science and art of acquiring information about the Earth's surface without being in contact with it (Franklin and Wulder, 2002). Accordingly, in the last few decades, a wide range of image processing procedures, especially focusing on DTI and dissimilar NNC methods are provided, each with its own goals, strengths, and weaknesses (Nelson and Khorram, 2018).

Methods of extracting information through the indexing of satellite images have been common for many years, among these, may refer to NDVI and NDWI indicators with their advantages and limitations (Thenkabail et al., 2018). In recent years, intending to overcome the limitations of traditional methods in the processing of satellite images, new indexing methods have been introduced to high-light land surfaces such as vegetation cover, soil, and water bodies, by addressing a combination of fuzzy and thresholding methods (Rasouli et al., 2020). Traditionally, two indexes of NDVI and NDWI are well-known and widely used land-cover indicators (Rehman and Hussain, 2018). Nevertheless, there are other effective indexes such as NBRI and AVBI for better quantifying of vegetation and soil conditions and more importantly the rate of risk and vulnerability of LU types by war actions, fire events, and other destructive human activities (Pettorelli, 2013). Of course, the use of these indicators is associated with some limitations such as not recognizing and separating vegetation accurately, or mixing wetlands with water bodies. Nevertheless, it is possible that to justify and reduce such limitations by imposing rule-based thresholding methods and processing high-resolution satellites such as Sentinel-2 imagery (Sentinel-2 MSI User Guides, 2020).

In a more precise step of satellite image processing, the NNC method could be used based on fuzzy classification functions to classify image objects with more than one LU class (Khatami et al., 2016). NNC must be regarded as an advanced

method in object-based classification that comes close to its capability to classify high spatial resolution Sentinel-2 images. The reason is that we have the advantage of using intelligent image objects with multiresolution segmentation in combination with a supervised classification outline. This allows researchers to select samples for each LU class, by defining some criteria (rule-based algorithms) for classification procedure inside the eCognition software that classifies all objects segmented in the image (eCognition Reference Book, 2019). Before this stage, a Multi-Resolution Segmentation (MRS) must be fined that aggregates spatial information into groups that finds logical objects in the satellite RGB combined imagery (Baatz and Schape, 2000). For example, MRS produces thin and long objects for water channels or roads, and it creates square objects of varying scales such as lakes or agricultural fields in the combined imagery bands of blue, green, red, infrared, and so on. To run any MRS procedure there is a need to define a few criteria parameters such as Scale Shape, and Compactness to get ideal image objects. As a rule of thumb, it is possible to produce image objects at the biggest possible scale, but furthermore, be able to discern between objects. By selecting training samples and a well-represented number of samples for assigned LU classes (such as forest, pasture, agricultural, and water surface) the classification process could be run based on the objects. The selected samples and the defined statistics expecting to reach the NN classification produce the final products, even though there are still a couple of options to improve the accuracy (Foody, 2002).

The authors believe that, after the liberation of the occupied territories, LC and LU changes would be perhaps the most important concern in many districts of the Karabakh Region (Rasouli et al., 2018b). It is recognized such contentious negative changes can significantly impact regional climate, ecosystem stability, water balance, stream silt up, biodiversity, and socioeconomic practices, thereby impinging on the regional economic progressing and overall quality of life in the coming years. Intending to extract accurate information from the resulting changes in the research topic, the basic objectives of the current study are: (a) applying DTI methods to understand the initial status of LC during the last period of the occupation stage inside the Aghdam District; (b) creating more accurate methods of rule-based NNC maps to access more details of LU status and resulting changes within the central district of Karabakh, which have been most affected during the occupation period. These aims could be accompanied by accurate information that facilitates future rehabilitations planning (Rasouli et al., 2021a).

THE STUDY AREA

The study area is specified to the Aghdam District that located in the Karabakh Economics Region, with its most recognized city of Aghdam. The geographical location of the study area is presented in Fig. 1. Aghdam is one of the 66 districts of Azerbaijan and is located in the west of the country and belongs to the Karabakh Economic Region. Most of these districts were under the occupation of Armenian forces following the First Karabakh war in the early 1990s (Sayilan, 2007). However, as part of the 2020 Karabakh war victory, Aghdam and the surrounding districts were returned to Azerbaijani control on 20 November 2020.

In the current study, two Sentinel-2 images (approximately sized to 110 * 108 Km dimension) were subsetted to cover the entire area of the Aghdam District. At the same size, they superimpose the Aghdam District and as well large parts of the administrative regions of Azerbaijan, including Ganja-Qazakh, Kalbajar-Lachin, Aran, and Karabakh that is one of the most important economic regions of Azerbaijan (Aliyev, I. The President of the Republic of Azerbaijan, 2021). The Aghdam District represents the geographical and strategic importance of all sounded districts in the region. Therefore, the entire range of two Sentinel-2 satellite images was taken on 12 August 2016 (during the occupation of the territory of Azerbaijan by Armenia forces) and on 21 August 2021, nearly about nine months after the recapturing of the occupied territories.

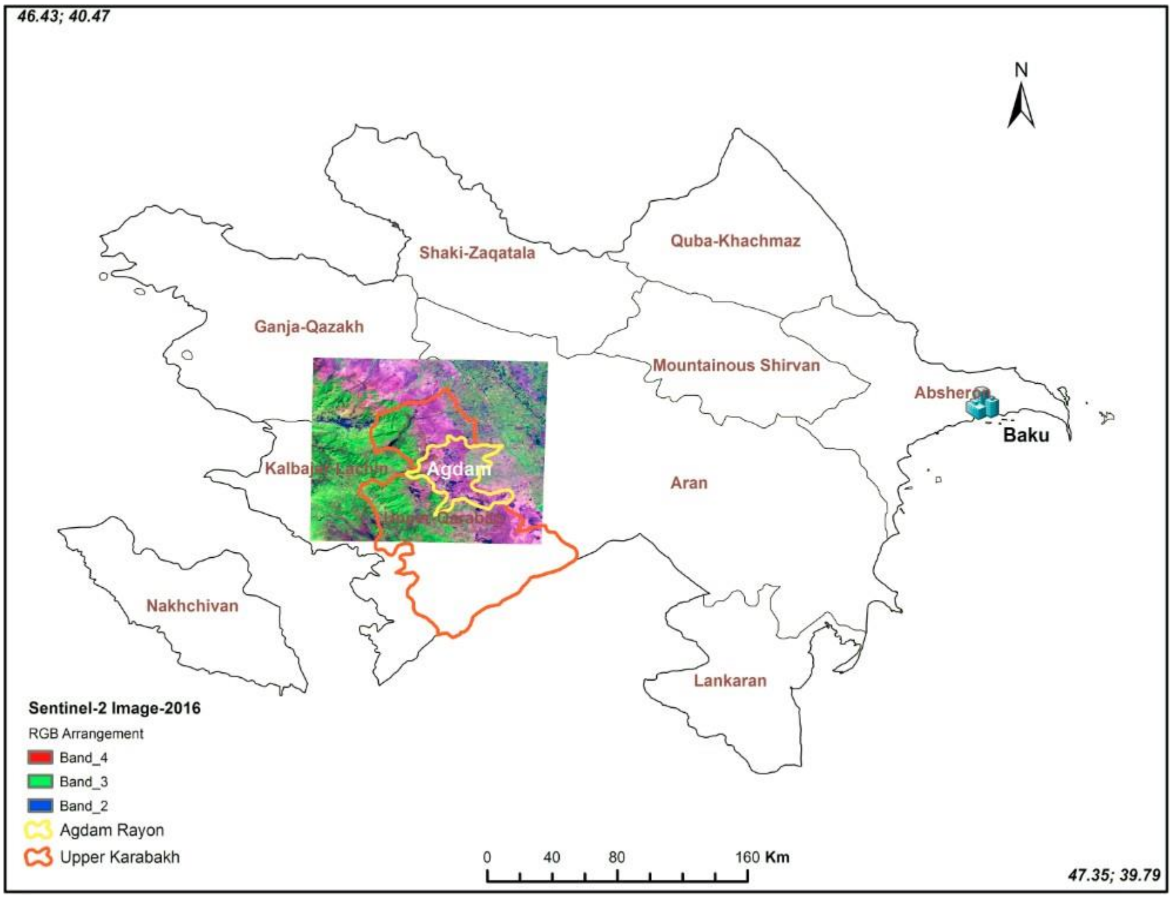


Fig. 1. The geographic location of Aghdam District in Azerbaijan and indicating of the Sentinel-2 image extension

Aghdam has a mainly warm semi-arid climate that could change to the wet conditions in the western parts would be affected by region complex relief and enduring water bodies. Most of the land in the study area includes agriculture, pastures, and unique forests (Rasouli et al., 2018c). Forests spread in the mountainous parts of the study area, gradually become lower and, create subalpine and alpine meadows. The occupation of the Azerbaijan territories by Armenia caused significant damage to the unique LC/LU types such as pasture, forests, especially those located in the frontal lines inside the Aghdam District, with a very rich flora species of higher plants (Valigholizadeh and Karimi, 2016). During the occupation period, agriculture became abounded and less economically important on the regional scale (FAOSTAT, 2014).

DATA PROCESSED AND TECHNIQUES APPLIED

a) Image Collection

To access the main aims of the current study, we analyzed two images from Sentinel-2 satellite acquired by ESA's Open Access (https://scihub.copernicus.eu), selected for specific dates, characterized in Table 1. Sentinel-2 is a European wide-swath, high-resolution, multi-spectral imaging mission. The full mission specification of the twin satellites flying in the same orbit but phased at 180°, is designed to give a high revisit frequency of 5 days at the Equator. Due to the balanced vegetation cover and the absence of cloud cover in the summer months, the satellite images are limited related to August months were processed (Sentinel Online, 2018).

Table 1. Basic information of the Sentinel-2 satellites

Band Number	Basic Descriptions	Wavelength Range (μm)	Central Wavelength (μm)	Spatial Resolution (m)
1	Coastal Aerosol	0.433–0.453	0.443	60
2	Blue	0.4575–0.5225	0.490	10
3	Green	0.5425–0.5775	0.560	10
4	Red	0.65–0.68	0.665	10
5	Vegetation Red Edge 1 (VRE1)	0.6975–0.7125	0.705	20
6	Vegetation Red Edge 2 (VRE2)	0.7325–0.7475	0.740	20
7	Vegetation Red Edge 3 (VRE3)	0.773–0.793	0.783	20
8	Near-Infrared (NIR)	0.7845–0.8995	0.842	10
8A	Vegetation Red Edge 4	0.855–0.875	0.865	20
9	Water Vapor	0.935–0.955	0.945	60
10	Shortwave Infrared Cirrus	1.36–1.39	1.375	60
11	Shortwave Infrared $_a$	1.565–1.655	1.610	20
12	Shortwave Infrared $_b$	2.1–2.28	2.190	20

Sentinel-2 MSI covering 13 spectral bands (443–2190 nm), with a swath width of 290 km and a spatial resolution of 10 m (4 visible and NIR bands), 20 m (six red edge and shortwave infrared bands) and 60 m, three atmospheric correction bands (Sentinel-2 MSI User Guides, 2020). For both sample sites, the Sentinel-2 images were processed for investigating the changes of LC/LU for the years 2016 and 2021. The selection of study areas required the consideration that the experimental areas are representative and, thus, the vegetation and non-vegetation types in the study areas should be abundant and diverse. Water bodies include lakes, rivers and water reservoirs, and non-vegetation types include bare-land and other emerging classes such as degraded and burned lands. Fig. 2 shows two samples of Sentinel-2 images with 3 band combinations for years 2016 and 2021, with the highest spatial resolution (10*10 m). The reduction of vegetation is completely detectable, particularly the rapid decline of green cover is visible across the region. Even, the soil salinization process can visually be observed in the region marked with white, reddish, and orange colours in the satellite imagery (Sentinel-2 MSI, 2020).

b) Image Processing

To build the image dataset, the aforementioned Level 1C (TOA – Top of Atmosphere reflectance) images were chosen based on the low cloud cover percentage and pre-processed for atmospheric correction with the Sen2Cor plugin (SNAP software – Sentinel-2 Toolbox) provided by ESA (Szantoi and Strobl, 2019). Following the atmospheric correction, we obtained Level 2A (bottom of atmosphere reflectance) which is more useful than TOA reflectance when trying to detect a process on the surface such as vegetation and water, because of the atmospheric effects caused by the event itself are reduced. Then, each corrected multispectral satellite imagery was imported to the eCognition software setting, and accordingly, mixed RGB layers were created. To obtain functional information from the satellite images, we proposed a tool, called estimation of scale parameter (ESP), that builds on the idea of local variance (LV) of object heterogeneity within a scene (Ikokou and Smit, 2013). When segmentation settings were modified based on the ESP - depending on the image quality (bands available, and image spatial-resolution) pixels of any satellite image were grouped into image objects before object-based indexing and classification methods could be performed. In the segmentation stage of satellite images, for scale parameter is taken about 55 and the shape and compactness indexes (with trial and error) were suggested as 0.3 and 0.7 respectively. The other main features of Sentinel-2 image layer weighting and segmentation parameters are presented in Table 2.

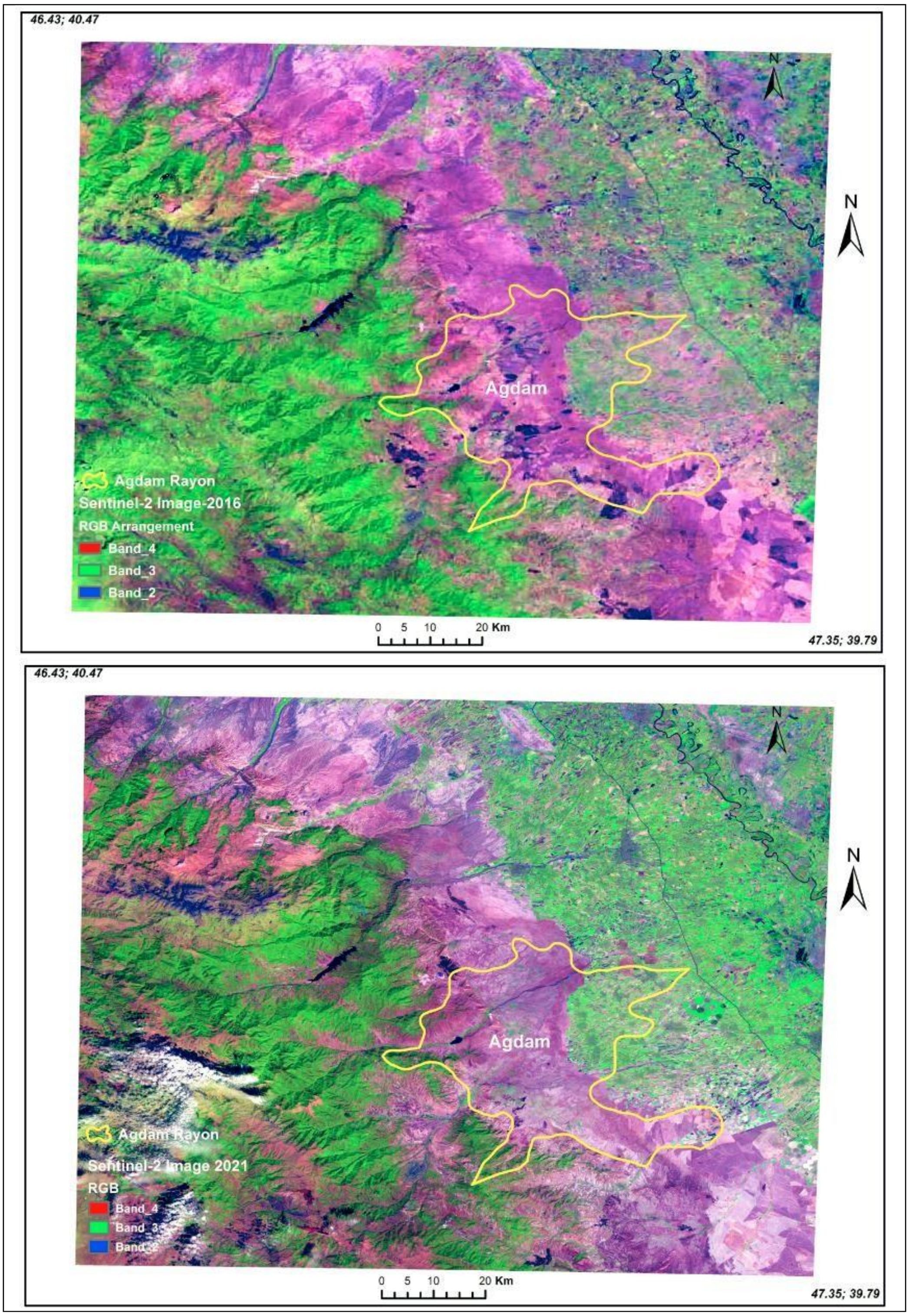


Fig. 2. Samples of Sentinel-2 imagery reflecting green cover destruction adjusted for the entire Aghdam District for years 2016 and 2021

Table 2: The main features of Sentinel-2 image layer weighting and segmentation features

Bands	b2	b3	b4	b7	b8	b8a	b11	b12
Image RGB Layer Mixing & Weighting	B1	B3	G1	G3	R1 & G1	R3	R1	--
Segmentation Setting	1	1	1	1	2	2	1	1

Along with implementing DTI procedures, equations 1-4 were step-wisely applied to create the basic NDWI, NDVI, NBRI, and AVBI indexes. In the dynamic thresholding stage, each index is regarded as an indicator of specified land surfaces, which typically refers to a spectral measure of the change in the satellite image band's reflections (Dozier, 1989).

$\boldsymbol{NDWI}_{S2} = "(\boldsymbol{b3} - \boldsymbol{b8}) / (\boldsymbol{b3} + \boldsymbol{b8})"$ *(Equation 1)*
If mean NDWI >= 0.1; classified as Water
$\boldsymbol{NDVI}_{S2} = "(\boldsymbol{b8} - \boldsymbol{b4}) / (\boldsymbol{b8} + \boldsymbol{b4})"$ *(Equation 2)*
if mean NDVI >= 0.25; classified as Vegetation
$\boldsymbol{NBRI}_{S2} = "(\boldsymbol{b8a} - \boldsymbol{b12}) / (\boldsymbol{b8a} + \boldsymbol{b12})"$ *(Equation 3)*
If mean NBRI >= 0.12; classified as Burned Lands
$\boldsymbol{AVBI}_{S2} = "(\boldsymbol{b2} + \boldsymbol{b3} + \boldsymbol{b4}) / \boldsymbol{3}"$ *(Equation 4)*
If mean AVBI >= 2000; classified as Degraded Lands

Inside the eCognition Developer version 9.5, based on the above-mentioned equations any index layer calculation algorithm inserts a new image layer by differentiating between dissimilar band combinations (Rasouli and Mammadov, 2020a). In usage, the NDWI index was first used NIR radiation and visible green light to enhance the presence of water bodies while in the study area by eliminating the presence of soil and terrestrial vegetation features. In turn, the NDVI standardized vegetation index allowed us to generate an indicator showing the relative biomass on the image. The chlorophyll absorption in the red band and relatively high reflectance of vegetation in the NIR band are used for calculating NDVI values. Furthermore, an NBRI was applied to the Sentinel-2 bands to capture likely burned lands in the local scales. It is a numerical indicator that combines Vegetation Red Edge (b8a) and Shortwave Infrared (b12) bands**.** Along with the other indicators, the standardized burning index NBRI has been used to highlight the burned areas, while muffing the difference in lighting and atmospheric conditions. It is ideal for detecting localized burned areas, especially in the detection of burned or burning places (farmlands and pastures) which intentionally were set on fires (Simone et al., 2020). Fire-affected areas have relatively low near-infrared reflectance (NIR) and high reflectance in the short-wave infrared band (SWIR). It should be noted that in the process of adjusting the above-mentioned indicators, the Average Visible Brightness Index (AVBI) was regulated by trial-and-error thresholds, with the goal of recognizing and producing existing degraded lands.

Lastly, for quantitative analysis of Sentinel-2 images, the NNC supervised classification procedure was used to create LU maps based on the OBIA structure (Kato, 2020). Supervised classification involves the use of training area data that are considered representative of each LU type to be classified, consists of a few major steps. First, after the creation of required projects inside the eCognition setting, multiresolution segmentation algorithms and parameters are set and executed in the creation of certain image objects. Then, inside the Class Hierarchy box different classes of water, forest & pasture, agriculture, barren-lands, degraded and burned lands (as vulnerable classes) were defined according to the objects structure in the image object domain and their nearest sample neighbors. The nearest neighbor classifies image objects in each feature space and with given samples for the classes of concern, inside the eCognition software, needed for each type of class. After a representative set of samples, objects have been declared, the algorithm searches for the closest sample object in the defined feature space for each image object. It selects the highest accurate features to be considered for the feature space closest sample object belongs to LU classes by applying certain membership functions allows defining the highest relationship between feature values and the degree of membership to a class using fuzzy logic operators. Then, if the image object differs from the sample, the feature space distance has a fuzzy dependency on the distance to the nearest sample classes during the NNC procedure (Kamusoko, 2019).

In a few cases, especially when classes were not clearly distinguished on the image sketch, the Sample Editor window, as a principal tool for checking samples, was applied to automatically

generate membership functions. It was also used to compare the attributes or histograms of image objects and samples of different classes. It is helpful to get an overview of the feature distribution of image objects or samples of specific classes. The features of an image object can be compared to the total distribution of this feature over one or all image object levels. In addition, to assess the quality of samples the Sample Selection Information window was applied to decide if an image object contains new information for a class, or if it should belong to another LU class. To ensure that the output LU maps are reliable, and quantitative accuracy methods were employed to assess the producer's accuracy, user's accuracy, overall accuracy, and Kappa coefficient of NNC classification. In the end, applying different accuracy assessment tools, such as the Stability dialog box and The Error Matrix (based on TTA Mask) it was possible to produce statistical outputs to increase the quality of the classification results (eCognition Developer, 2021).

RESULTS

a) Indices LC Maps

To compare the changes of LC types all over the study area the water body, vegetation, non-vegetation, and vulnerable classes are shown in Fig. 3. The decrease in vegetation can be traced inside the Aghdam District by accurate examination of LC classes during the last years with significant negative changes inside the study area. Looking closely at the amounts of LC classes on the legend of maps in Fig. 4, it could be detected that the amount of vegetation cover over the last 6 years has reduced nearly to about 27.8 km^2 (10.2 %). At the same time, about 78.2 km^2 (11.8 %) has been added to the Non-Vegetated LC. Meanwhile, Vulnerable Lands were changed by about 45.1 km^2 (-26.8 %), even though this amount was at its maximum in 2016 with 168.4 km^2. This amount decrease could be related to the reduction of deliberate fires in the green-covers and ended the abolition of land occupation. To achieve more accuracy, it was necessary to create LU maps with more classes and accurate NNC techniques.

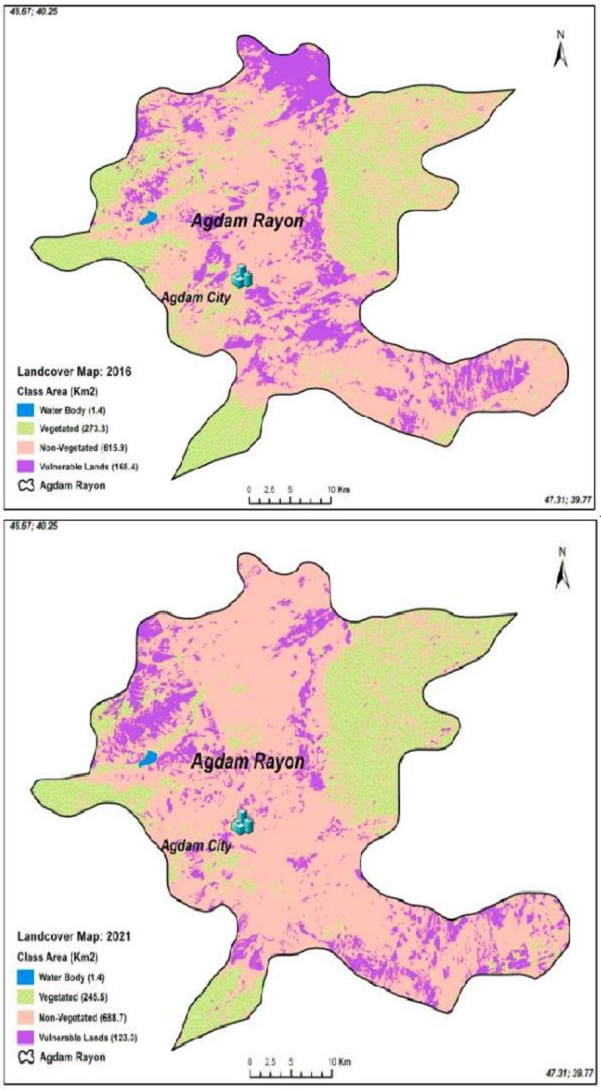


Fig. 3. LC maps produced by indexing techniques adjusted for the Sentinel-2 imagery 2016 and 2021

b) Classified LU Maps

By introducing MRS algorithms and NNC procedures, LU maps, with six classes, were produced and adjusted for the Aghdam District. To be certain about the result of NNC the performance of closing LU classes was cheeked in detail with different image mixed layer weights and multiresolution segmentation parameters (Fig. 4).

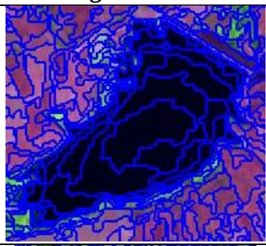
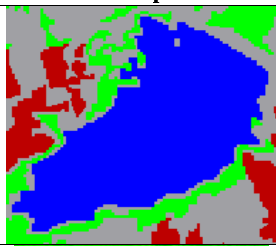
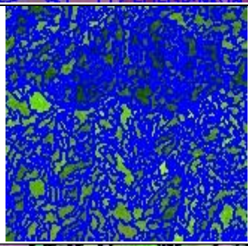
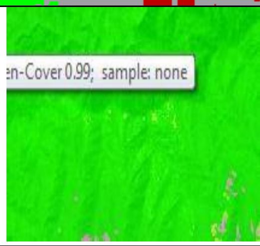
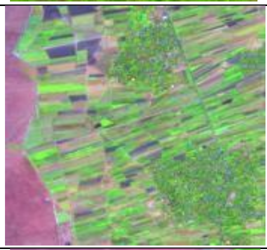
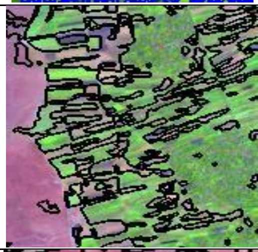
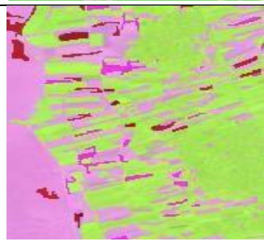
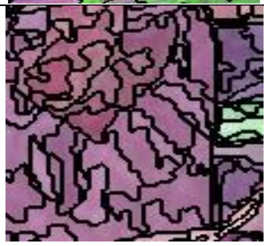
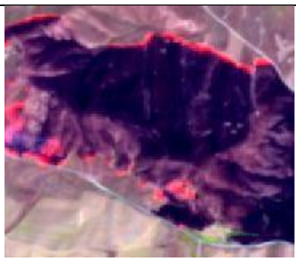
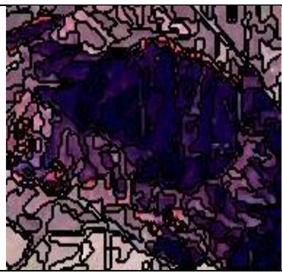
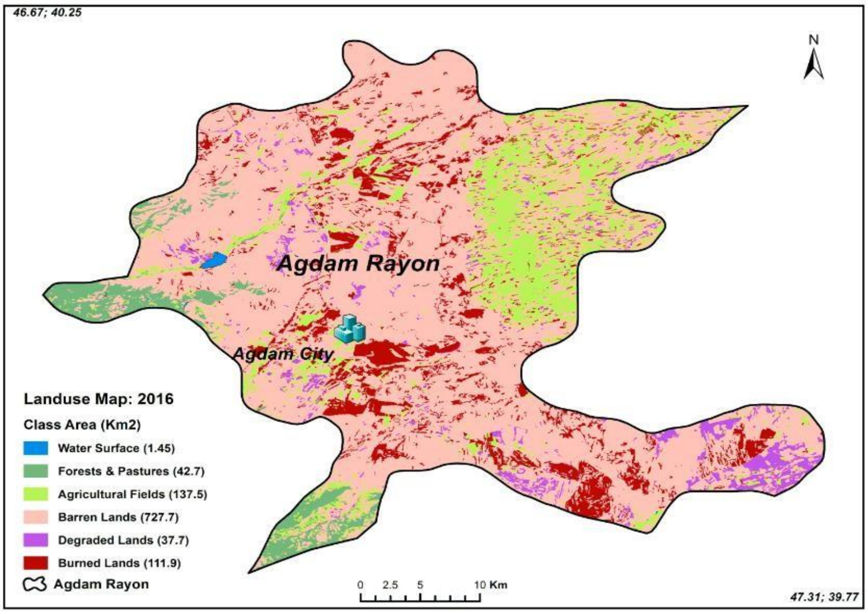
NNC Steps / Landuse	Image Layer Weighted & Mixed	Multiresolution Segmentation	Classified Map
Water Surface			
Forests & Pastures			
Agricultural Fields			
Barren Lands			
Degraded Lands			
Burned Lands			

Fig 4. The performance of final NNC classified LU classes, examples with different image mixed layer weights, and multiresolution segmentation



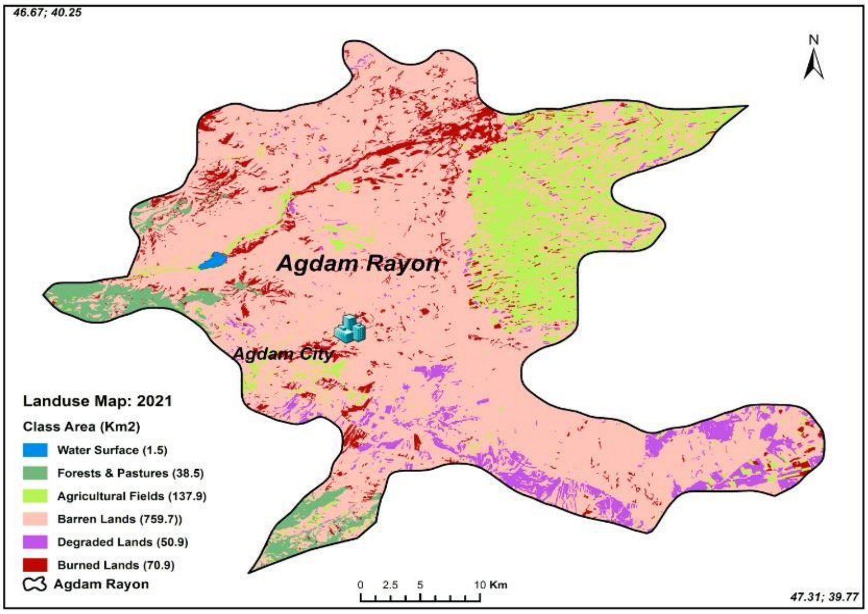


Fig. 5. Final LU maps of 2016 and 2021 classified by NNC techniques

Due to the careful visual interpretation and a quantitative accuracy index, the performance (for each class) was controlled, and promising accurate maps were produced. By carefully testing the preformed samples, produced layers were imported to the ArcGIS setting and final classified LU maps of 2016 and 2021 were mapped (Fig. 5).

Examination of the resulting LU maps indicated that the reduction in forests & pastures (-9.8%) and barren lands (+4.4%) inside the Aghdam District are quite considerable (Fig.5). As it is noticeable in Fig 6, changes in other classes are also evident by emerging more degraded lands (+35%) and reducing burned lands (-36.9%). Amounts of raise in water surface class (+3.4%) and agricultural fields (+0.3%) are not quite meaningful from 2016 to 2021.

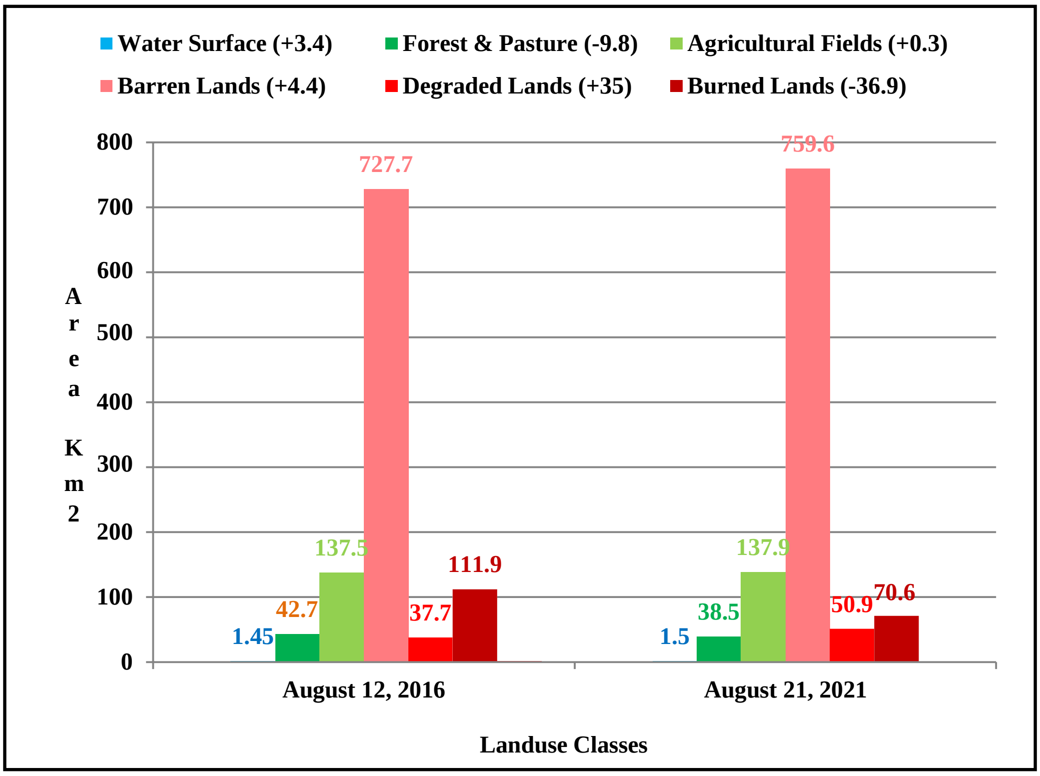


Fig. 6: Changes in the LU types in 2016 and 2021 adjusted to the Aghdam District. The values in parentheses (in %) indicate a decrease (-) or increase (+) concerning any of LU classes

DISCUSSION

During the long-term occupation stage, the fundamental driving force of LC/LU changes has been related to war activities such as the compulsory seizure of agricultural and livestock activities, along with the destruction of rare forests (IDMC, 2021). Moreover, we should consider the uncontrolled erosion of soil, pasture, and unique historical monument buildings destruction caused by unprincipled mining activities, multiple bomb- ings, and land-mine landings within the occupied territories (Hajiyeva, G. 2021). Eventually, the improper landuse and lack of proper care of human and natural re- sources led to widespread destruction and even extinction of many plants and wildlife species in the region (Baumann et al., 2013).

Thereafter, our main goal was to assess LC and LU changes inside the Aghdam District by applying OBIA DTI and rule based NNC methods respectively. Primary, to understand the extent of changes in basic LC types, we processed multi-temporal Sentinel-2 imagery (sampled for 2016 and 2021) and introduced a few rule-based indexes of NDWI, NDVI, NBRI and, AVBI consequences. It was found that alongside the study area, reduction of LC was accelerated during the recent years, and continuously green covers are being destroyed, particularly by degrading and burning procedures during the occupied periods (notice Fig. 3). With emphasis, vulnerable areas were defined in two states of burned and degraded lands that are areas that have lost a major degree of their natural productivity due to war-caused processes (Gibbs and Salmon, 2015). Other effective factors contributing to the rapid destruction of vegetation and soil loss include fires that are proposed by war behaviors and agricultural needs (Kust et al., 2017). Both destructive factors are influential in the process of LC/LU changes by properly using indicators, as were applied in the current study. Hence**,** DTI methods could be effective methods by enclosing the spectral, spatial, multitemporal, and multisensory information; and incorporation of ancillary data into indexing procedures (Mammadov and Rasouli, 2020).

Furthermore, the OBIA segmentation and NNC results (figures 5 and 6) indicated that the vegetation trend (particularly forests and pastures) is negative in the decreasing mode and the LU changes are signs all over the Karabakh Region (Hay and Castilla, 2006; Rasouli et al., 2021). As the result of the rule based NNC technique indicated the amount of burned lands in 2021 was much (36.9 %) lower than in 2016. This reduction can certainly be related to the recapturing of the occupied territories and the reduction of deliberate fires in the region. Nevertheless, accuracy assessment, with an overall accuracy of 0.95 and Kappa statistics with 93 %, was an integral part of the current study DTI and NNC procedure. Without doubts, uncertainty and error propagation in the modern image-processing chain is still an important factor influencing the final LU map's accuracy (Blaschke, 2010). Ultimately, identifying the weakest links in the chain and then reducing the uncertainties is critical to the improvement of digital image processing accuracy (Lobo and Chick, 1996). For future investigators, increasing the accuracy of the results of similar research field operations is a necessary profession.

CONCLUSION

The current introductory study's main goal was to map the LC/LU changes by the processing of satellite Sentinel-2 imagery inside the Aghdam District for the years 2016 and 2021. Considering so, the other objectives of this research were to evaluate the potential of the OBIA functions of DTI and rule based NNC methods inside the eCognition Developer setting. Based on these approaches, the following results were obtained:

- ✓ during the occupation period, LC and LC types have continuously been changed.
- ✓ LC and LU detection and mapping was a crucial task in previously occupied districts, by the processing of moderate resolution Sentinel-2A (10 m) images, in place of commercial satellite images, enable LU mapping with little to no cost.
- ✓ the OBIA methods could be regarded as a subdiscipline of geo-information science devoted to partitioning remote sensing imagery into meaningful image objects and assessing their characteristics through spatial, spectral, and temporal scales.
- ✓ although the OBIA is found to be a very advanced image processing procedure, nevertheless we think that it could be compared in future research along with quite professional programs as Support Vector Machine, and Machine-Learning / Deep-learning approaches to detect highly accurate LU changes with high confidence.
- ✓ by processing high-resolution imagery, we may carry out much more detailed information by expanding the study site to other liberated districts with an emphasis on the Karabakh Region to visualize the most likely reduction in green covers and associated damages that have been imposed on the country valuable ecological resources.
- ✓ a multi-platform and multi-purpose real-time monitoring system is almost immediately required if it is not yet too late. Such reclamation projects could be managed by Azeri-nation staff to do this critical nationwide advanced engagement.

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Qarabağ iqtisadi rayonu torpaq örtüyü və torpaqdan istifadədəki dəyişikliklərin Ağdam rayonu daxilində peyk şəkillərinin obyekt yönümlü təhlili əsasında xəritələşdirilməsi

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Erməni silahlı birləşmələri tərəfindən Qarabağın və ona bitişik ərazilərin 30 illik işğalının ekoloji nəticələrinin araşdırılması və müəyyən edilməsi vacib və təxirəsalınmaz vəzifələrdən biridir. Ağdam rayonu daxilində erməni işğalından azad edilmiş ərazilərdə torpaq örtüyünün və torpaqdan istifadənin (LC/LU) vəziyyətini və ehtimal edilən dəyişiklikləri öyrənmək üçün obyekt yönümlü görüntü analizi (OBIA) prosedurları tətbiq edilmişdir. Əvvəlcə, bir neçə spektral indekslərdən istifadə etməklə - NDWI, NDVI, NBRI və AVBI, torpaq örtüyünü (LC) əks etdirmək üçün dinamik fərq indeksinin (DTI) alqoritmləri tətbiq edilmişdir. Sonra, tədqiqat sahəsi daxilində dəqiq torpaqdan istifadə dəyişikliklərini müəyyən etmək üçün Trimble eCognition platformasında təkmilləşdirilmiş nəzarət sinifləndirmə metodu olan ən yaxın qonşu təsnifatı (NNC) metodundan istifadə edilmişdir (eCognition Developer, 2019).

Dinamik həddlərin indeksləşdirilməsi (DTI) alqoritmlərinin istifadəsi göstərdi ki, 2016-2021-ci illərdə Ağdam rayonu daxilində torpaq örtüyündə (LC) olduqca əhəmiyyətli dəyişikliklər baş vermişdir, bitki örtüyünün əhəmiyyətli dərəcədə azalmış (10,2%), bir hissəsi tamamilə məhv olmuş (11,8%), həssas torpaqlarda olduqca nəzərə çarpan dəyişikliklər (26,8%) meydana çıxmışdır. Ən yaxın qonşu klassifikasiya metodu (NNC) əsasında bir neçə torpaq istifadəsi dəyişiklikləri aşkar edilib: meşə və otlaq sahələrinin 9,8% azalmış, deqradasiya olunmuş torpaq sahələri 35%-ə qədər, qeyri-münbit torpaq sahələri 4,4%-ə qədər artmışdır və bu proses davam etməkdədir. Qeyd edək ki, su səthinin və kənd təsərrüfatı torpaqlarından istifadədə (LU) dəyişikliklər daha az müşahidə olunmuş və müvafiq olaraq 3,4% və 0,3% təşkil etmişdir. Ümumi dəqiqliyin 0,95 və Kappa əmsalının 93% olması torpaq örtüyü və torpaqdan istifadənin (LC/LU) vəziyyətində baş vermiş dəyişikliklərin statistik əhəmiyyətli olduğunu təsdiq edir. Beləliklə, səlahiyyətli hökümət nümayəndələrinin bərpa və layihə işlərinə başlamaq haqqında qərar verməsindən əvvəl, Azərbaycanın azad edilmiş rayonlarının hazırkı vəziyyətinin hərtərəfli analizi və xəritələşdirilməsi coğrafiyaçıların, ekoloqların və uzaqdan alqılama mütəxəssislərinin ən təxirəsalınmaz vəzifələrinə çevrilməlidir.

Açar sözlər: *Ağdam rayonu, Qarabağ, torpaq örtüyü və torpaqdan istifadənin dəyişməsi (LC/LU), Sentinel-2 şəkilləri, OBIA əsasında dinamik və həddi indeksləşdirmə, ən yaxın qonşu təsnifatı (NNC)*

Картирование изменений земельного покрова и землепользования в Карабахском экономическом районе на основе объектно-ориентированного анализа спутниковых снимков в пределах Агдамского района

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Исследование и выявление экологических последствий 30-летней оккупации Карабаха и прилегающих к нему территорий армянскими вооруженными формированиями, является одним из важных и актуальных задач. Для изучения состояния и вероятных изменений земельного покрова и землепользования (LC/LU) на освобождённых от армянской оккупации территориях Карабаха в пределах Агдамского района были использованы процедуры объектно-ориентированного анализа изображений (OBIA). Сначала были применены алгоритмы динамической индексации пороговых значений (DTI) для отображения земельного покрова (LC) путём разработки нескольких спектральных индексов NDWI, NDVI, NBRI и AVBI. Затем, с целью выявления точных изменений землепользования внутри исследуемой области, был использован усовершенствованный контролируемый метод классификации в рамках настройки Trimble eCognition - метод классификации ближайшего соседа (NNC) (eCognition Developer, 2019). Результаты динамической индексации пороговых значений (DTI) показали, что с 2016 по 2021 годы внутри Агдамского района произошли существенные изменения земельного покрова (LC), значительное уменьшение растительного покрова (10,2%), увеличение невегетативной зоны (11,8%) и появление довольно заметных изменений на ранее оккупированных землях (26,8%). Впоследствии, методом классификации ближайшего соседа (NNC) были обнаружены различные отрицательные изменения землепользования внутри исследуемой области - сокращение лесов и пастбищ на 9,8%, увеличение площади деградированных земель до 35% и бесплодных земель до 4,4%. Следует отметить, что минимальные изменения наблюдались для водной поверхности и сельскохозяйственного землепользования (LU) до 3,4% и 0,3%, соответственно. Значения общей точности 0,95 и коэффициента Каппа 0,93 подтвердили статистическую значимость

изменений состояния земельного покрова и землепользования (LC/LU). Следовательно, точная обработка изображений и картирование текущего положения освобожденных районов Азербайджана должны стать наиболее актуальными задачами ученых географов, экологов и специалистов по дистанционному зондированию до того, как лица, принимающие решения в правительстве, приступят к проектам реконструкции и реабилитации.

Ключевые слова: *Агдамский район, Карабах, изменения земельного покрова и землепользования (LC/LU), снимки Sentinel-2, динамическая и пороговая индексация на основе OBIA, контролируемая классификация* ближайшего соседа *(NNC)*

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Biological diversity of forest ecosystem of the Basitchay State Nature Reserve

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The study analyzed the natural plant species of the Basitchay State Nature Reserve, located in the south of the Lesser Caucasus, Zangilan region, the population status of plants in the areas, the taxonomic composition of trees, shrubs, and grasses. For this purpose, the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan and the Institute of Dendrology of ANAS got acquainted with the current situation in the liberated area. During the monitoring, satellite images, GPS coordinates, etc. were used. Soil samples brought from the area were studied for 14 parameters of mineral content using Palintest soil kits 400 equipment. In the forest cover of the mountainous part, on dry rocky slopes, areas of natural distribution of plants are depicted. As a result, 27 species of trees, 18 shrubs, and 11 types of grass were recorded in the Basitchay State Nature Reserve. Of these species, 17 rare endangered trees, 3 shrubs, 3 types of grass, 6 trees and 2 shrubs of relict, and endemic species were identified.

***Keywords:** Lesser Caucasus, the Basitchay State Nature Reserve, the condition of the population, relict and endemic species, rare species*

INTRODUCTION

Heydar Aliyev, who fought against the ecological terror policy of the Armenians when the plane-tree forest in Basitchay gorge was threatened with extinction since the 1950s, submitted a project to the Cabinet of Ministers in 1959 to create a reserve to protect the plane-tree forest. Due to the intervention of pro-Armenian officials, this project submitted by Azerbaijan was met with indifference. Armenians, who created a reserve in the Armenian part of the forest in 1960, took an active part in the deterioration of the territories belonging to the Azerbaijani side of the forest. The project submitted by Heydar Aliyev was supported by the decision of the Council of Ministers of the Azerbaijan SSR dated July 4, 1974, by transferring to the Basitchay State Nature Reserve 107 hectares of natural plane-tree forest on an area of 117 hectares located in the south of the Lesser Caucasus, Zangilan region. This is one of the greatest achievements of Heydar Aliyev in the fight against the environmental terror policy of Armenia.

The plane-tree forest in the Basitchay valley is a unique pearl that belongs not only to Azerbaijan but to all European nature. With the transfer of Zangazur to Armenia in the first years of Soviet rule in Azerbaijan, part of the plane-tree forest in the Basitchay valley - trees along the Khachin River and Shikhavuz river valleys - remained in Nerkin-Hand, Sav, and Shikhavuz villages of Gafan region. The atrocities committed by the depraved enemy have threatened to destroy the certified Eastern plane trees in the area. The Eastern plane tree (*Platanus orientalis* L.) is dominated in the Basitchay State Nature Reserve. There is a large number of 100-200 years old, 80-120 cm in diameter, and 25-30 meters high specimens.

MATERIALS AND METHODS

Analysis of natural plant species of Basitchay State Nature Reserve, the population status of plants in the areas, the taxonomic composition of trees, shrubs, and grasses were analyzed on the basis of (Grossheim, 1939), Engler and APG systems.

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The Diva-Gis system was used to obtain environmental parameters in the study area. Hypsometric height and area coordinates were measured by Garmin eTex 20 model GPS. During the monitoring, various literature from satellite images (Hajiyev and Musayev, 1996), T.Ibrahimov, 2010),) and internet data: (http: //www.anl.az›down›meqale›baki; https://imbb.az› news; http://bizimasr.media-az.com/arxiv_2002/ sent.09/208/sosium.html; http://bizimasr.media-az.com/arxiv_2002/sent.09/208/sosium.htm) was used.

The plane-tree forest, which is the object of research, the second in the world and the first in Europe, is protected in the Basitchay reserve. The name of the reserve is of Mongol origin and is named after the Beysut tribe. Plane forests in the Basitchay valley occupy 93.5% of the reserve. The territory of the reserve located in the Zangilan region is mainly mountainous, located at an altitude of 600-800 m above sea level. The right bank has steep slopes and the left bank consists of hills. The area has a temperate-hot climate with dry winters. Its territory consists of alluvial-forest soils, chestnut, gray-brown, grass-meadow soils with brown mountain-forest soils in the surrounding areas **(**Ibrahimov, 2010). It is characterized by geographical location, soil-climatic conditions, diversity of plant species in forests, and fertile soil.

RESULTS AND DISCUSSION

The main purpose of the study was to study the natural area of plant taxa of Basitchay State Nature Reserve, assess the ecological condition of the area, and determine the level of anthropogenic exposure.

For this purpose, the director of the Institute of Dendrology of ANAS, corresponding member of ANAS Tofig Mammadov together with the representatives of the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan got acquainted with the current condition of the liberated area. Satellite images, various data and GPS coordinates were used during the monitoring.

Natural *Amorpha fruticosa* L., *Platanus orientalis* L., 12-15 km along the Basitchay, which starts from the eastern slopes of the Zangazur range; (*Ananim, 1970*) in the north with xerophyte forest cover consisting of *Pistacia vera* L., *Mespilus germanica* L., *Celtis caucasica* Willd., *Rhamnus pallasii* Fisc. & C.A.Mey, *Paliurus spina-christi* Mill., *Crataegus monogyuna* Jacq. and others; to the south is a forest massif of *Quercus orientalis* and *Carpinus orientalis* Mill (Table 1).

During the monitoring, it was observed that the plane tree, which occupies the first tier of the forest in the area, was mixed with ordinary walnut (*Juglans regia* L.). *Celtis caucasica* was found in the second tier, and poplar (*Populus* L.), elm (*Ulmus* L.), and long-stemmed oak (*Quercus longipes* L.) were found along the river. The taxonomic composition of trees, shrubs, and grasses of the area is grouped and reflected in Tables 1 and (Mammadov et al., 2016).

Relict and endemic plant species were also studied in the area and a total of 7 species were identified - 5 trees and 2 shrubs (Table 2).

Table 1. Taxonomic composition of tree plants in Basitchay State Nature Reserve

In the forest cover of the mountainous part	**On dry rocky slopes**	**At altitudes from 800 m to 1400 m, in the massif of Surtun**
1. *Platanus orientalis* L.	1. *Quercus araxina* Grossh.	1. *Amygdalus fenzliana* Lipsky
2. *Quercus iberica* M.Bieb.	2. *Celtis caucasica* Willd.	2. *Amygdalis narica* Fed.et
3. *Juglans regia* L.	3. *Carpinus orientalis* Mill.	3. *Diospyros lotus* L.
4. *Celtis caucasica* Willd.	4. *Pyrus boissieriana* Buhse	4. *Juniperus foetidissima* Willd.
5. *Morus nigra* L.	5. *Acer iberica*	5. *Juniperus polycarpos* K.Koch.
6. *Carpinus caucasica* Grossh.	6. *Ulmus araxina* Tacht.	6. *Taxus baccata* L.
7. *Salix* L.	7. *Pyrus salicifolia* Pall.	7. *Corylus colurna* L.
8. *Juniperus* communis L.	8. *Juniperus foetidissima* Willd.	8. *Quercus longipes* Steven
9. *Pistacia mutica* Rech.f.	9. *Elagnus orientalis* L.	
10. *Populus* L.		

As a result of the monitoring, 10 species were identified in the forest cover of the mountainous part of the Basitchay State Nature Reserve, 9 on dry rocky slopes, and 8 species in the Surtun massif at altitudes from 800 m to 1400 m.

Relict, endemic rare, and endangered plants were also studied, grouped, and tabulated in the Basitchay Reserve. 17 rare and endangered trees, 6 shrubs, and grasses were observed in the reserve (Table 3, 4) (Salaev, 1991).

Table 2. Relict, endemic trees, shrubs, and grasses of Basitchay State Nature Reserve.

Trees
1. *Platanus orientalis* L.
2. *Pterocarya pterocarpa* Kunth ex I. Iljinsk.
3. *Corylus colurna* L.
4. *Juniperus foetidissima* Willd.
5. *Diospyros lotus* L.
Shrubs
1. *Punica granatum* L.
2. *Crataes eriantha* A. Pojarк.

Table 3. Taxonomic composition of shrubs and grasses of the reserve

Shrubs (18)
Paliurus spina-christi Mill.
Sambucus ebulus L.
Punica granatum L.
Cotoneaster integerrimus Medik.
Cotoneaster melanocarpus Fisch. ex A.Blytt
Rhamnus pallasii Fisch. & C.A. Mey.
Berberis densiflora Boiss. & Buhse
Rosa sachokiana P. Jarosch.
Jasminum fruticans L.
Crataegus eriantha A. Pojarк.
Atraphaxis spinosa L.
Mespilus germanica L.
Pyracantha coccinea M.Roem
Spiraea sp.
Ephedra intermedia Schrenk. Et. C.A.Mey.
Cerasus microcarpa (C.A. Mey.) Boiss.
Lonicera iberica M.Bieb.
Myriacaria squamosa Desv.
Herbaceous plants (12)
Iris paradoxa Steven.
Andropogon sp.
Teucrium sp.
Thymus sp.
Xeranthemum sp.
Stellaria media (L.) Vill.
Poa annua L.
Geranium molle L.
Urtica dioica L.
Taraxacum vulgare Schrank
Crocus adamii J.Gay
Ophrys caucasica Woronow ex Grossh.

Table 4. Rare and endangered trees, shrubs, and grasses of Basitchay State Nature Reserve.

Rare and endangered tree plants
1. *Juglans regia* L.
2. *Quercus iberica*
3. *Celtis caucasica* Willd.
4. *Corylus colurna* L.
5. *Salix caucasica* Anderss
6. *Taxus baccata* L.
7. *Pistacia mutica*
8. *Populus nigra* L.
9. *Pyrus boissieriana* Buhse
10. *Quercus araxina* Grossh.
11. *Pyrus salicifolia* Pal.
12. *Amygdalis narica* Fed.et
13. *Acer ibericum* M.Bieb
14. *Juniperus foetidissima* Willd.
15. *Amygdalus fenzliana* Lipsky
16. *Taxus baccata* L.
17. *Quercus longipes* Steven
Rare and endangered grasses and shrubs
1. *Pyracantha coccinea* M.Roem
2. *Rosa sachokiana* P. Jarosch.
3. *Atraphaxis spinosa* L.
4. *Ophrys caucasica* Woronow ex Grossh.
5. *Crocus adamii* J.Gay
6. *Iris paradoxa* Steven.

As a result of the monitoring, *Platanus orientalis* L., *Taxus baccata* L., *Corylus colurna* L., *Quercus arachnid* Grossh. were found in the area., *Pterocarya pterocarpa* Kunth ex I.Iljinsk., *Celtis caucasica*, *Pyrus boissieriana* Buhse., *Pyrus salicifolia* Pal. Along with rare and endangered relict species such as *Pistacia mutica*, *Diospyros lotus* L., *Punica granatum* L., *Vitis sylvestris*, *Morus nigra*, *Elagnus orientalis* species have been identified as endangered as a result of the abominable actions of Armenians (Ananim, 1989). 5 species listed in the Red Book in the reserve - *Platanus oriaentalis* L., *Pyracantha coccinea* M. Roem. (Mammadov T.S. 2016). *Iris paradoxa* Steven. *Crocus adami* J.Gay., *Ophrys caucasica* Woronow observed (Fig.1). The soil sample brought from the territory of Basitchay State Nature Reserve by the Institute of Dendrology of ANAS was analyzed with Palintest Soil equipment. (Hajiyev and Musayev, 1996). The soil sample brought to the "Plant Ecology" laboratory of the Institute was studied with 14 parameters according to the mineral content by means of "Palintest soil kits 400" equipment (Fig. 2). The results are shown in Table 5.

Table 5. Results of the analysis of the soil sample brought from Zangilan-Basitshay State Nature Reserve.

EXAMPLE	Depth (sm)	pH	Electric conductiv. m/ms	NO_3^-	K^+	NH_4^+	Cu^{2+}	Mg^{2+}	SO_4^{2-}	$P_2O_5^{3-}$	Ca^{2+}	Cl^-	Al^{3+}	Fe^{2+}	Mn^{2+}
	Standard	7	-	0-25 µg /l	0-450 µg /l	0-75 µg /l	0-25 µg /l	0-500 µg /l	0-300 µg /l	0-150 µg /l	0-250 µg /l	0-1000 µg /l	0-50 µg /l	0-25 µg /l	0-25 µg /l
Roadside	10-25	7.8	520	>>	350	<<	7.0	120	65	49	4250	2375	0.8	4.2	<<
Riverside	10-25	7.1	920	27.0	360	0.5	18.4	370	65	0	3750	2250	<<	21.8	0.0



Pyracantha coccinea M.Roem.



Iris paradoxa Steven.



Crocus adami J.Gay.



Ophrys caucasica Woronow ex Grossh.

Fig. 1. Species included in the Red Book of the reserve



Fig. 2. Analysis of soil sample brought from Basitchay State Nature Reserve in the laboratory with Palintest Soil equipment

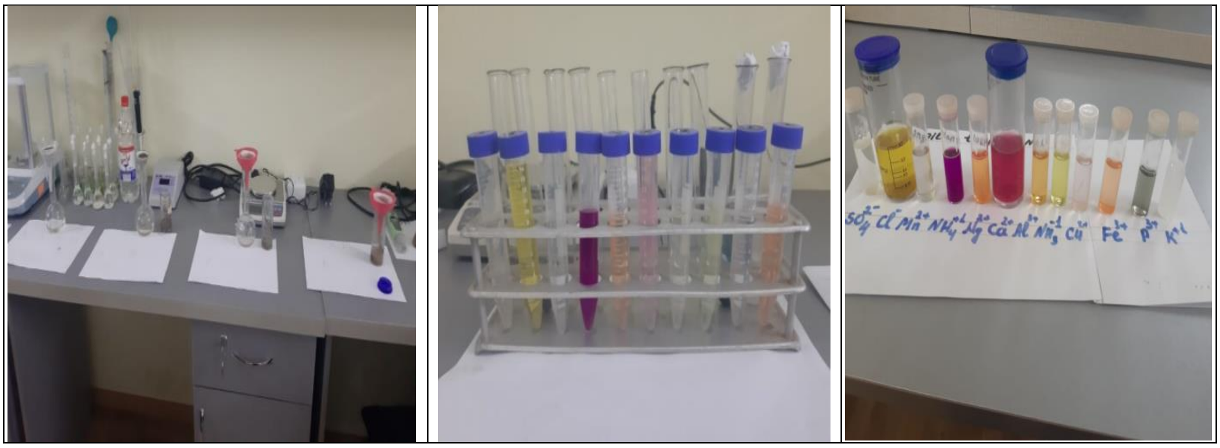


Fig. 3. View of analysis of 14 parameters according to mineral content with "Palintest soil kits 400" equipment.

The first soil sample is taken from the reserve area on March 6, 2021, from a depth of 10-25 cm in a medium-yield area, the analysis revealed that the soil pH was weakly alkaline, electrical conductivity was 520 cm/mS, contains metal ions. There is a lot of nitrate-nitrogen (NO_3), which indicates that nitrogen bacteria are active in the soil (Fig.3). Potassium ions are present in the area (K^+) at 350 mg / g, confirming the low water holding capacity of the soil. If you look at the ammonium ion (NH^{+4}) in the soil, almost no organic fertilizer was applied to the area. In the example, copper ions (Cu^{2+}) are about 3 times higher than the standard value, the area that belongs to the pasture. Magnesium ions (Mg^{2+}), on the other hand, are 2 times lower than the standard, sulfur ions (SO_4^{2-}), and phosphorus ($P_2O_5^{3-}$) ions are 3 times lower than the standard. These indicators show that mineral fertilizers have not been applied to the soil for a long time

In this example, Ca^{2+} salts and chloride salts 3 times higher than the standard confirms that the area is moderately saline. Aluminum ion is only 0.8 mg/g, iron ion (Fe^{2+}) is very small, manganese ion (Mn^{2+}) is completely absent. According to the above-mentioned analytical analyzes, the application of organic and mineral fertilizers to such lands can allow obtaining productivity.

The second example is coastal soils with a pH of 7.1, ie a neutral environment. This proves that the area is constantly washed away by water. Due to the leaching of organic and mineral elements from the soil, the electrical conductivity is high due to heavy metal ions - 920 cm/mS, nitrate nitrogen is only 27.0 mg/g, potassium ions (K^+) 360 mg/g, which indicates poor soil moisture capacity. Lack of organic fertilizer in the soil, copper ions, magnesium ions below the standard, 5 times the sulfur

compounds, the absence of phosphorus ions confirms that the soil is unsuitable for cultivation. The content of calcium and chloride ions in these soils is higher than the standard and is significantly saline. Aluminum and manganese ions were not found in the sample, and iron ions were close to the standard. It is not expedient to select such lands as arable lands (Salaev, 1991).

During the monitoring of Basitchay State Nature Reserve located in the Zangilan region, 27 trees, 18 shrubs, and 11 grass species were registered, of which 18 trees, 3 shrubs, 3 grass species are rare and 5 endangered trees and 2 shrubs are relict and endemic plants (Table 6, 7).

Table 6. Rare and endangered plants.

Plants	Number of species
Tree plants	17
Grasses and shrubs	6
Relict and endemic	7

Table 7. Area of distribution of tree plants in the territory of the reserve.

Place	Number of species
Of the mountainous part in the forest cover	**10**
On dry rocky slopes	**9**
At an altitude of 800 m to 1400 m, in the Surtun massive	**9**

The damage caused to the ecology and natural resources of Azerbaijan as a result of the occupation of our territories by Armenia is immeasurable. Karabakh's natural resources, especially plant resources, have been ruthlessly looted by Armenians. They are the most looted forests after the gold extracted from our occupied lands for 30 years. Trees were cut down and destroyed in a part of the Chinar forest in the Basitchay State Nature Reserve. Red oak trees were uprooted and cut down, furniture was produced and most of them were sold to foreign countries. The reserve was looted by Armenians and threatened to completely destroy the vegetation in the area. All this is the terrorist damage inflicted on nature, natural monuments and the environment as a whole by Armenians.

CONCLUSIONS

Eastern plane trees were cut down, various explosives were used to destroy the roots of the broken trees, and fires broke out in the area, which led to the destruction of the reserve. As a result of monitoring, in the forest cover of the mountainous part of the area, *Quercus iberica* and *Carpinus caucasica*, 2 species of *J. foetidissima*, *Juniperus depressa* Stev. and *Pistacia mutica*, walnut, hackberries, mulberry, willow, poplar, hawthorn, rosa, buckthorn, dry-steppe, mountain xerophilous plants, shrubs, blackthorn, etc. found.

On dry rocky slopes *Q. araxina*, *Celtis caucasica* Willd., *C. orentalis*, *P. mutica*, *Acer iberica*, *Ulmus araxina*, *Pyrus salicifolia* forms sparse forests with juniper. These forests include xerophytic shrubs: *Atraphaxis spinosa*, *Lonicera iberica*, *Cerasus microcarpa*, *Ephedra intermedia* Schrenk. Et. C.A.May., *Jasminum fruyicans*, *Rhamnus pallasii* and *Paliurus spina-christi* are naturally distributed.

In general, as a result of monitoring, 27 species of trees, 18 shrubs and 11 species of grasses were registered in the Basitchay State Nature Reserve. Of these, 17 trees, 3 shrubs, 3 grass species were identified as rare and endangered plants, and 6 trees and 2 shrubs were identified as relict and endemic plants.

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Bəsitçay Dövlət Təbiət Qoruğunun meşə ekosisteminin bioloji müxtəlifliyi

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Tədqiqat zamanı Kiçik Qafqazın cənubunda, Zəngilan rayonu ərazisində yerləşən Bəsitçay Dövlət Təbiət Qoruğunun təbii bitki növlərinin təhlili, areallarda bitkilərin populyasiya vəziyyəti, ağac, kol və ot bitkilərinin taksonomik tərkibi araşdırılmışdır. Bu məqsədlə AR Ekologiya və Təbii Sərvətlər Nazirliyi və AMEA Dendrologiya İnstitutu birgə işğaldan azad olunmuş ərazinin mövcud vəziyyəti ilə tanış olmuşlar. Monitorinqlər zamanı peyk görüntülərindən, GPS kordinatlardan və s. istifadə edilmişdir. Ərazidən gətirilmiş torpaq nümunələri “Palintest soil kıts 400” avadanlığı vasitəsilə 14 parametrlə mineral tərkibə görə öyrənilmişdir. Ərazinin dağlıq hissəsinin meşə örtüyündə, quru daşlı yamaclarda təbii halda yayılan bitkilər təsvir edilmişdir. Nəticədə Bəsitçay Dövlət Təbiət Qoruğunda 27 növ ağac, 18 növ kol və 11 növ ot bitkisi qeydə alınmışdır. Bu növlərdən nadir və nəsli kəsilməkdə olan 17 ağac, 3 kol, 3 ot bitkiləri, relikt və endemik növlərdən isə 6 ağac, 2 kol bitkisi müəyyən olunmuşdur.

Acar sözlər: *Kiçik Qafqaz, Bəsitçay Dövlət Təbiət Qoruğu, populyasiya vəziyyəti, relikt və endemik növlər, nadir növlər*

Биологическое разнообразие лесной экосистемы Баситчайского государственного природного заповедника

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В ходе исследования проанализированы естественные виды растений, популяционный статус, таксономический состав деревьев, кустарников и трав на территории Баситчайского государственного природного заповедника, расположенного на юге Малого Кавказа, в Зангиланском районе. С этой целью Министерство экологии и природных ресурсов Азербайджанской Республики и Институт дендрологии НАНА ознакомились с текущей ситуацией на освобожденной территории. При мониторинге использовались спутниковые снимки, координаты GPS и др. Привезенные с территории пробы почвы были исследованы по 14 параметрам минеральности с помощью оборудования Palintest soil kits 400. В лесном покрове горной части участка сухих каменистых склонов наблюдается естественное распространение растений. В результате в Баситчайском государственном заповеднике зарегистрировано 27 видов деревьев, 18 кустарников и 11 видов трав. Из этих видов выявлено 17 редких исчезающих деревьев, 3 кустарника, 3 вида трав, 6 деревьев и 2 куста реликтовых и эндемичных видов.

Ключевые слова: *Малый Кавказ, Баситчайский государственный природный заповедник, состояние популяции, реликтовые и эндемичные виды, редкие виды*

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Geography of population longevity hotspots in Azerbaijan

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Abstract: The global aging of the world's population and the increase of the share of older age categories in its structure, which has become one of the distinctive features of the demographic transformation of the modern world, has aroused the ever-growing interest of researchers of various profiles in gerontological problems. The study of the phenomenon of the group or population longevity, which is noted in some regions of the world, called "blue zones", has acquired particular importance. The data of complex biomedical studies of populations with an increased longevity index carried out on the territory of Azerbaijan since the end of the last century indicate the potential of some regions of the country to obtain the status of a "blue zone". The study of the geography of the longevity spread among the indigenous population of the country reveals the presence of "natural" centers of longevity in certain regions, in particular in Karabakh, where, thanks to a rare combination of favorable natural-ecological and social conditions, the indigenous population has historically emerged and consolidated, i.e. an increased concentration of long-lived people has been traced for quite a long time. The article provides a map of the distribution of such centers of longevity in Azerbaijan and discusses the compliance of some regions, in particular Karabakh, with the criteria of the "blue zone".

Keywords: *Human ageing, demographic transformation, population longevity, blue zones, Karabakh*

INTRODUCTION

According to UN forecast, the world population will increase by 40% in the next 40 years. But the nature of this increase will be fundamentally different from what humankind has experienced in the past, due to two global trends: declining birth rate and increasing average life expectancy, that feature the demographic make-up of the modern world (Sharman, 2011). In other words, the world's population will not grow because of the high birthrate, as it always did previously, but mainly as a result of increased numbers of older people. In the near future, the number of people aged 80 and over will be about the same as the population of children under 5 years (Anbdrews, 2002).

One inevitable consequence of population ageing is an undesirable rise in the proportion of those suffering from age-related disease and disability. In this regard, the multidisciplinary research on so-called *Blue Zones*, in which, as shown in many studies, people live exceptional longer and healthier lives than average, is of paramount importance. The findings of these studies widen the existing knowledge on the nature of human ageing as well as on how and to what extent all the socioeconomic, behavioral, environmental, and genetic factors individually, jointly, and interactively contribute to exceptionally long and healthy lives. Therefore, for the last few decades, the phenomenon of Blue Zones has been attracting increasing attention from gerontologists and specialists of related disciplines (Poulain et al., 2013).

In general, the BZ population is characterized by a significantly higher level of longevity compared to the neighboring regions, provided that the exceptional longevity of people in this population has been fully validated. In practice, a blue zone is defined as a rather limited and homogenous geo-

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graphical area where the population shares the same lifestyle and environment and its longevity has been proved to be exceptionally high. A number of studies have shown that the BZs exist in different parts of the world including the South of Europe (Italy, Greece), Latin America (Costa-Rica), Japan (Okinawa), USA (Loma-Linda California) (Poulain et al., 2013).

A high concentration of the long-lived is observed in the Caucasus countries including Azerbaijan (Козлов, Комарова, 1982). A number of studies by gerontologists mostly from the former Soviet Union's scientific community have found that with the longevity indices reaching up to 20-50 ‰ in some areas Azerbaijan can be considered as one of the world's longevity hotspots. The individual longevity records have been reported in the country as well (Козлов, 1989). Availability of such unique human resources opens up unique prospects for multidisciplinary research both on the individual and the population longevity as a complex biomedical and psycho-social phenomenon. It is not surprising that Azerbaijan has been in the focus of the specialists engaged in human ageing studies since the first epidemiological survey in 1986 which was carried out by the international team of experts from the Institute of Physiology, Azerbaijan National Academy of Sciences, jointly with the Kiev Institute of Gerontology (Ukraine), the Research Institute for Human Studies (USA) and the Institute of Ethnology, Russia. It was found that among the aboriginal population of Azerbaijan there has naturally-historically emerged and been fixed the high concentration of people representing maximal species-specific lifespan (Kuznetsova et al., 2016). Those findings opened up the unique possibilities for the multidisciplinary study of complex medical-biological and social-cultural factors underlying the formation of the 'longevity phenomenon' at the population level which was launched in 2015 when a dedicated academic programme was developed by the Garayev Institute of Physiology of NANA aimed at a comprehensive study of populations with the elevated longevity indices (Гашимова и др., 2019; Рашидова и др., 2019; Carbone et al., 2020; Rashidova et al., 2020).

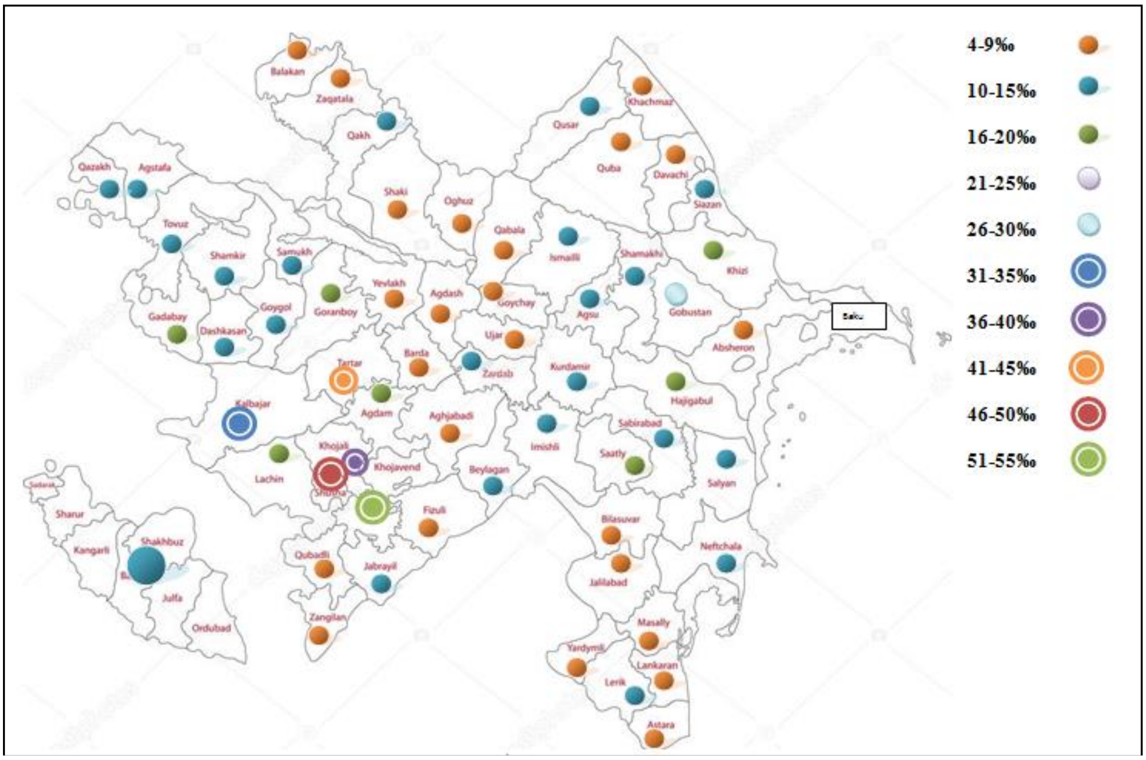


Fig. 1. Geography of Longevity in Azerbaijan

One of the major findings of this programme is associated with the geography of longevity in the country. It was shown that even though the cases of age 90+ are reported for in various areas of Azerbaijan, the regions of their particularly high concentration are distributed unevenly. Specifically, the highest concentration of long-living people is characteristic for the Karabakh region, particularly for the Shusha and Khojavend districts, where the longevity index (share of those at age of 90+ in the total population aged 60+) is reaching up to 50-54 ‰ (Fig. 1). The comparison of our findings with the data available in the literature regarding the geography of longevity hotspots in the Caucasus has revealed that in those areas the highest longevity indices have been reported since 1926, indicating that in this mountainous area the longevity phenomenon has naturally-historically emerged and been fixed for generations (Козлов В., Комарова О., 1982). One more striking point is that in the latest census data of 2016 that were used in our demographic elaborations, the populations of Shusha and other Karabakh settlements were registered not in their historical land of residence, but in the places of their temporary residence. It appears that despite nearly 30 years of life in completely different social-environmental settings, those people have managed to preserve the biological potential ensuring better adaptation to physical and social environments and longer life.

At present, new surveys are under development in a comparative way for the areas in the country with elevated longevity indices, involving biomedical and environmental aspects. A comprehensive approach is being considered, favoring the analysis of numerous biomedical, social and environmental factors that could have interacted to result in exceptional longevity hotspots.

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Azərbaycanda uzunömürlülüyün yayılma coğrafiyası

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Müasir dünyanın demoqrafik transformasiyasının səciyyəvi xüsusiyyətlərindən biri olan dünya əhalisinin qlobal şəkildə yaşlanması və bu strukturda yaşlı nəsil kateqoriyasının payının artması müxtəlif profilli tədqiqatçıların herontoloji problemlərə getdikcə artan marağına səbəb olmuşdur. Dünyanın bəzi bölgələrində "mavi zonalar" kimi qeyd olunan qrup və ya populyasiya uzunömürlülüyü fenomeninin öyrənilməsi xüsusi əhəmiyyət kəsb edir. Azərbaycan ərazisində yüksək uzunömürlülük indeksinə malik olan populyasiyalarda ötən əsrin sonlarından başlayaraq kompleks şəkildə aparılan biotibbi tədqiqatların nəticələrinə əsasən demək olar ki, ölkənin bəzi bölgələri “mavi zona” statusunu almaq potensialına malikdirlər. Belə ki, yerli əhali arasında uzunömürlülüyün yayılma coğrafiyasının tədqiqi ölkənin ayrı-ayrı bölgələrində "təbii" uzunömürlülük ocaqlarının olduğunu aşkara çıxarmışdır. Xüsusilə də Qarabağda, əlverişli təbii-ekoloji və sosial şəraitin nadir birləşməsi sayəsində yerli əhali arasında uzunömürlülüyün geniş yayılması təbii-tarixi olaraq yaranmış və möhkəmlənmişdir, yəni bu kifayət qədər uzun müddət ərzində izlənilmişdir. Məqalədə Azərbaycanda bu cür uzunömürlülük mərkəzlərinin yayılma xəritəsi verilir və bəzi bölgələrin, o cümlədən Qarabağın “mavi zona” meyarlarına uyğunluğu müzakirə edilir.

Açar sözlər: *İnsanın qocalması, demoqrafik transformasiya, populyasion uzunömürlük, mavi zonalar, Qarabağ*

География распределения очагов долгожительства в Азербайджане

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Глобальное старение населения планеты и увеличение в его структуре доли старших возрастных категорий, ставшее одной из отличительных особенностей демографической трансформации современного мира, вызвало всевозрастающий интерес исследователей разного профиля к геронтологической проблематике. Особое значение приобрело изучение феномена группового или популяционного долгожительства, который отмечается в некоторых регионах мира, получивших название «голубых зон». Данные комплексных медико-биологических исследований популяций с повышенным индексом долгожительства, проведенных на территории Азербайджана, начиная с конца прошлого века, свидетельствуют о потенциале некоторых районов страны для получения статуса «голубой зоны». В частности, изучение географии распространения долгожительства среди коренного населения страны выявляет присутствие «естественных» очагов долгожительства в отдельных районах, в частности в Карабахе, где, благодаря редкой комбинации благоприятных природно-экологических и социальных условий, у коренного населения естественно-исторически возникла и закрепилась (т.е. тенденция прослеживается в течение довольно длительного времени) повышенная концентрация долголетних людей. В статье приводится карта распределения таких очагов долгожительства в Азербайджане и обсуждается соответствие некоторых районов, в частности Карабаха, к критериям «голубой зоны».

Ключевые слова: *Старение человека, демографическая трансформация, популяционное долгожительство, голубые зоны, Карабах*

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Ethnobotanical analysis of Karabakh

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The ethnobotanical characterization of Karabakh has been discussed in the paper. Based on surveys and literature data, 101 species of medicinal plants, 44 species of wild food - fruits and berries, 28 species of wild vegetables, 20 species of spices, 10 species of dyes and more than 300 forage plants were widely used by humans in the area. Although data on some areas (Shusha, Khankendi, Khojavend) were obtained from local temporary settlers and refugees' communities, Tartar and Barda districts were fully inspected, and plants were collected from some villages in Fizuli, Agdam and Agjabadi districts. Frequencies of use were determined. In the course of the study, the methods of using plants by modern and classical ethnobotanical methods were determined. Further research is expected to address the effects of the war.

Keywords: *Karabakh, flora, medicinal and food plants, ethnobotany*

INTRODUCTION

Plants meet basic human needs such as medicine, agriculture, food and fodder. Some important plants no longer play such an important role in the economic life of the population, as people displaced from their ancestral lands have already settled in big cities and both plants and their uses have been forgotten since the territory of Karabakh has been under occupation for 27 years. The present-day Karabakh belongs to the Karabakh economic region of the Lesser Caucasus botanical-geographical region of Azerbaijan formed with rich flora and colorful vegetation. Some of these territories have been completely occupied, some of them have been occupied and looted by the ongoing conflict. More than 35% of the total plants in the flora of Azerbaijan have spread in this area (Flora of Azerbaijanç, 1952-1961). 70% of the species composition of the region is spread in modern Azerbaijan, which is a small part of the Caucasus as can be seen from the results of long-term and detailed botanical-systematic, geobotanical researches, as well as classical sources (Conspect of Flora of the Caucasus, 2003-2006).

The plants traditionally used in the territory of Karabakh were analyzed by V.A.Petrov (1940) about 80 years ago. Petrov's work is considered to be one of the most unique in terms of both theme and approach to the topic. The book contains extremely important materials not only for ethnographers but also for botanists. During the development of the collected materials, it became clear that there are many sources on the methods and forms of application of different species, based on the experience of the people on the use of different plant species. These only apply to herbs. At the same time, there is a very important group of plants (trees and shrubs) that do not play such an important role in the economic life of the population. However, plants are widely reflected not only in domestic use, but also in the ideology and culture of the people in the early stages of the history of the study. This issue was not touched upon in Karabakh after Petrov. The fact that 20% of Azerbaijani lands were occupied for many years did not allow research in the region, and although Armenians were considered to have occupied the territories, not only ethnobotany, but also a single sentence about vegetation.

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Karabakh is formed by rich flora and colorful vegetation. These include dense forests, wild vegetables and medicinal plants found in mountain meadows. At present, 4961 higher plant species belonging to 159 families and 1117 genera are distributed in Azerbaijan (Asgarov, 2016), of which more than 1500 are medicinal (Mehdiyeva, 2011; Ibadullayeva et al., 2013; 2018), up to 800 fragrant and spicy (Ibadullayeva et al., 2007), up to 200 wild vegetables (Kasumov et al., 2009; Asadov et al., 1989), etc. are useful plants (Munir et al., 2018; Ibadullayeva et al., 2010, 2012, 2015).

In fact, the territory of Karabakh got its name due to the rich vegetation, numerous medicinal plants and large fields. In the ancient Azerbaijani language, the word "gara" means "big" and "bag" means a "green area or garden", ie "big garden". According to ancient Greek scholars, in the Middle Ages, Karabakh was part of the Albanian state. According to the manuscripts, in the first century AD, Caucasian Albania exported medicinal plants in glass boxes to Rome. Apparently, in the first century, Karabakh challenged the world with its botanist (Alakbarli, 2009). One of the most famous doctors of Azerbaijan in the 16th century was Yusif Garabaghi, who was called a "genius teacher". He was born in Karabakh, spent most of his life and work in Central Asia, and taught at a madrassa in Samarkand.

As can be seen, the use of medicines by local communities in Karabakh dates back to ancient times, the search for and discovery of new treatments, the identification of methods to combat diseases, and so on, have long been influenced by Sufi views. However, despite these obstacles, the search for new treatments in nature, as well as their more affordable forms and methods of application, continued. There are a number of promising reasons for ethnobotanical research, ie the study of the various relationships between plants and humans, the connection with human culture in the Karabakh region: the first is the richness of flora and plant diversity of landscapes. The territory of Azerbaijan is one of the "hot-spot biodiversity" regions of the world due to its biological diversity, and let's not forget that Karabakh is the ancient and eternal territory of Azerbaijan. The second aspect that emphasizes the importance of studying the cultural interactions of this region is the cultural richness, antiquity and diversity of manifestations in the territories of Karabakh. Although a large part of the population of the area has settled in other regions for many years, a major return will be made to ensure that the ethnic use of Karabakh's medicinal plants is engraved in the repeated memories of local communities.

The most typical small areas of Karabakh are typical landscapes, corners with special beauty, endemic, relict and endangered species, perennial trees, examples of garden-park art, waterfalls, caves, rare lakes, groundwater wells, other places of interest in the territory of the Republic. manifested as natural monuments. The issue of collection (partial and limited collection) of rare and other protected species should be approached with extreme caution (Red Book of Azerbaijan, 2013). Plants can disappear in any region, and thus all knowledge about them can be destroyed, and sometimes this knowledge can disappear forever, for which information about plants must be constantly collected and communicated to people. The protection of plants remains an emotional and "occupying" issue, as there have been many wars in the occupied territories for many years in Karabakh, invasive plants continue to grow, and excessive collection of other essential plants has led to a decline in plant communities. Excessive use of plant resources, as well as over-harvesting and non-compliance with post-harvest regulations, and lack of control mechanisms have increased the pressure on biodiversity. Conducting ethnobotanical research in the regions is a way to develop new drugs for the treatment of diseases. Today, ethnobotany and ethnopharmacology are widely used to discover new compounds (Kahramanova et al., 2017; Oksana et al., 2021; Ibadullayeva, 2020).

Refresh the memory of local communities in the great return to the liberated areas and to re-instill in them the useful properties of plants is the main purpose of this study. On the other hand, the place has caught the local names of our lands, our people, our food, our music, and our neighbors, who have settled in our ancient lands, have even changed and adopted the names of our plants. The name given by the people to the object studied in each ethnographic work is of great importance. That is why, of course, we consider it expedient to name the plant not only by its Latin name but also by its local names.

MATERIALS AND METHODS

Information on the research area: Karabakh economic region consists of 9 administrative divisions as Khankendi, Khojavend, Agjabadi, Aghdam, Shusha, Fuzuli, Khojaly, Tartar and Barda, Garabagh and Zangazur mountain range. Approximately 1,000,000 of the district's total population is mainly of temporary settlers and refugees. Tartar district belongs to lowland Karabakh and is considered to be one of the oldest settlements. The region is located in the western part of the Kur-Araz lowland, in the Karabakh plain. The territory of the Tartar region is 957 km^2 and the population is about 104,200,000 people. Barda district is located in the North-Western part of the Kur-Araz lowland, with a total area of 957.00 km^2 and a population of 136,000. The area of Aghdam district is 1150 km^2, the population is 153000, the relief is mainly plain, partly mountainous. The territory of the Agjabadi district, one of the largest agricultural districts of the Republic of Azerbaijan at the time, is 1756 km^2 and has a population of 128,100 people. The relief of the Agjabadi district is a plain, gradually rising from the north-east to the South-West. Fuzuli covers the sloping plains and lowlands of the Karabakh mountain range from the South-Eastern foothills to the Araz River. It borders Iran along the Araz River.

The territory of the Fizuli district is 1386 km^2 and the population is about 144,000 people. We have not been able to register yet due to incomplete information on other areas (Khankendi, Shusha, Khojaven and Khojaly).

Selection of informants: A survey was conducted in March-April (2020) and June-July (2021) between Tartar and Barda districts to conduct ethnobotanical research. In order to obtain information about local plants, plants were registered and a questionnaire survey was conducted with communities to clarify their knowledge of plants and forms of use. Because clinics are inaccessible to the rural population around the world, they depend on the traditional use of local plants, including meeting the demand for food plants (vegetables) in the wild.

Data collection: Data-specific assessment was collected through direct interactions with local people and observations during visits (Guber, 2001; Martin, 2001; Suffering. ethnographer, 2007). Group meetings were held with people who had sufficient knowledge of local plants, and individual meetings were arranged with healers (lohman in azeri) in the villages to verify the information. During the study, 110 informants about 60 plants in the Tartar district were interviewed. A survey was conducted with 140 communities in the Barda district and information was collected on 34 plants and 20 plants obtained from other places in the area. No vegetation has been collected from other areas yet, and the area's flora will be fully inspected once the effects of the war are over.

Collection and identification of plants: Medicinal and wild food plants were collected from the research area and brought to the Department of Ethnobotany of the Institute of Botany of ANAS. Herbariums of these plants were prepared and identified. Herbarium specimens of plant species are kept in the herbarium after adaptation to the flora of Azerbaijan (Flora of Azerbaijan: in 8 vol., 1952-1961; Conspect of the flora of the Caucasus, 2003-2006).

Data analysis: Data collected from various fields (villages, districts, etc.) were analyzed using the SPSS 9.00 statistical program. Based on the responses collected from the informants, the use of plants, medicines and food products and applications prepared from them were considered. The data were calculated by the FC frequency of each plant species reported by local data providers. The relative importance of plant species was estimated by the following formula by calculating the cost of use, as described by Phillips and Gentry (1993). The value used for the species is UVi ¼ XUi = Ni, where the number previously referenced for each specific species is represented by Ui and the total number of data interviewed by Ni.

RESULTS AND DISCUSSION

Materials collected from Karabakh do not actually cover the plants used by the population. So far, the methods of using wild food plants, as well as whether they are used as medicine have been determined.

Numerous studies show that in order to understand the relationship between the activities of human society and vegetation is necessary to analyze the region ethnobotanically at first. Therefore, one of the main conditions is to collect data on how and

why plants are used among people, both now and in the past. People living in the area in the form of ethnic groups have used only plants as both food and medicine since the Stone Age, and many of them are still used today.

Some of the ethnobotanical data on plants in Karabakh were collected orally on the basis of surveys conducted in temporary settlers and refugees. Other surveys were conducted among local communities in Tartar and Barda districts, and some were conducted in some villages in other districts. In particular, it should be noted that a significant part of the material collected on the basis of oral information is quickly forgotten. Therefore, publishing books and papers in the mother tongue are important. The beginning of the integration of science into the economy is connected with ethnobotany. It should also be noted that ethnobotany is a hybrid science, where it is necessary to draw conclusions from historical, political, archaeological, economic and scientific facts. Karabakh is one of the ancient Turkic and Albanian settlements, as well as Azerbaijani lands.

The study collected data from more than 200 local communities in more than 60 villages and found that different ethnic groups living in Karabakh used plants for the same purpose and in the same way. Oral surveys revealed that species belonging to different chapters were named with the same toponym according to their area of use. Based on the results of oral surveys, 101 species of medicinal plants, 44 species of wild food - fruits and berries, 28 species of wild vegetables, 20 species of spices, 10 species of dyes and more than 300 fodder plants were identified in the area. At present, we know very little about the current state of these species, including their distribution, phytocenological features, role and resources in the vegetation type. However, we hope that expeditions will be organized in the near future to study the flora and fauna.

In addition to wet plants, horse milk, sour milk and dried herbs are widely used in the area as a treatment.

In the frequent expressions of communities, wormwood is considered a medicine of local communities in increasing appetite, in infectious diseases of the internal organs of St.John's wort, in the treatment of violet and rose headaches. Research on common ethnobotanical methods and surveys was carried out in the settlements of temporary settlers and refugees from most parts of the Karabakh region. Based on the experience of the people on the use of different plant species, field research has not yet been conducted in some areas. However, in a short period of time, a lot of material has been collected about the methods and forms of application of different species. At the same time, some very important plants have recently ceased to play such an important role in the economic life of the population, as refugees have already settled in large cities. As a result, it became clear that information about the importance of some forms of stagnant peasant activity in the economy and culture is still remembered. The most valuable data in the interviews was obtained mainly from the older generation. Although new forms of farming have emerged in recent years, the dominance of wild flora has rapidly collapsed for them, and information about some plants has almost been completely erased from memory. At present, to a certain extent, only folklore can give the impression of an eternal struggle between man and nature in the thinking of a society at a certain stage of development. The folklore information collected by ethnographers and archeologists in connection with material and cultural monuments really allows us to describe the history of Karabakh in a scientific way. Much of the past has probably been erased before it is written in the memory of the younger generation. For this reason, the best way to present the materials collected so far to the public after people return to their ancestral lands is considered.

Special rules for the collection of medicinal plants have been formed in folk medicine. The communities in the Karabakh region understand what they know about this: the medicinal plant must first be clearly identified. During the initial processing, after the raw material has dried, the non-compliant parts must be removed. Surface plant parts (leaves, flowers, grass, fruit) should be collected in the morning when it is dewy (between 8-10 am) and underground organs (roots, rhizomes)in the evening after 5 pm. Only need to collect well-developed healthy raw materials. Plants damaged by insects or microorganisms should be removed.

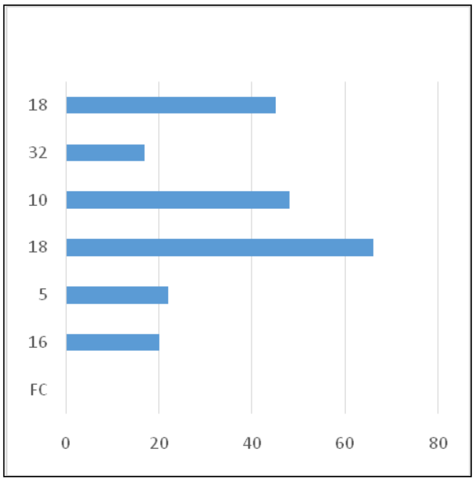
Vegetation of Karabakh is semi-deserts and semi-steppes in vertical zoning (up to 400 m above

sea level); steppe vegetation (400-800 m); mesophilic forests (1000-2000 m); high mountain vegetation (2000-2500 m); alpine-subalpine vegetation (2200-3000 m); rock vegetation (over 3,000) and wetland vegetation in river and lake deltas.

After obtaining information from other regions of Azerbaijan, it became clear that there are species that are unique to the area and their range is limited to Karabakh: *Sanguisorba officinalis* and *Salvia karabachenses.*

There are also some plants that are not found in the wild in the area, but are grown by people in the regions and used as medicine:*Tanacetum vulgare, Rosmarinus officinalis, Pimpinella anisum, Papaver somniferum, Mentha piperita, Matricaria matricarioides, Iris germanica, Kalanchoe pinnata, Ficus carica, Ephedra aurantica, Cucurbita maxima, Coriandrum sativum, Calendula officinalis, Bidens tripartita, Alliumsativum* and *Aesculus hippocastanum.*

During the research, the frequency of plant use (FC) in the local flora was determined (Figure) and different ways of using the more mentioned plants were identified.



Number of species

Fig. Some species for use

As you can see from the figure, 66 plants (*Bistorta major* S.F. Gray, *Chelidonium majus* L., *Convallaria majalis* L., *Bryonia alba* L., *Datisca cannabina* L., *Leonurus quinquelobatus* Gilib., *Nigella sativa* L.and etc.) by 18 times, 10 plants (*Cichorium intybus* L., *Crataegus transcaucasicus* Pojark., *Matricaria matricarioides (*Less.) Porter, *Calendula officinalis* L., *Helichrysum plicatum* DC., *Hippophae rhamnoides* L., *Mentha piperita* L. and etc.) 48 times have mentioned

In the territory of Karabakh by families: *Asteraceae* Dumort-17,*Rosaceae* Juss.- 8, *Lamiaceae* Lindl.-6, *Apiaceae* Lindl.-5, *Fabaceae* Lindl. and *Polygonaceae* Juss. -4, *Moraceae* L. and *Cucurbitaceae* Juss. -3, *Papaveraceae* Juss., *Violaceae* Batsch-2, *Viburnaceae* Barfin, *Valerianaceae* Batsch, *Monotropaceae* Nutt, *Anacardiaceae* Lindl., *Punicaceae* Horan, *Hippocastanaceae* DC., *Betulaceae* S.F.Gray, *Alliaceae* J.Agazdh., *Berberaceae* Juss., *Malvaceae* Juss., *Tilliaceae* Juss., *Brassicaceae* Burnett, *Sambucaceae* Batsch ex Borkh, *Rhamnaceae* Juss., *Fagaceae* Dumort, *Elaegnaceae* Juss., *Peganaceae* (Engl.) Tiegh.ex Takht, *Primulaceae* Vent, *Plantaginaceae* Juss., *Salicaceae* Mirb., *Chenopodiaceae* Vent., *Cupressaceae* Rich., *Ranunculaceae* Juss., Hyperiacaceae Juss., Cannabaceae Juss., *Elaegnaceae* Juss., *Urticaceae* Juss. each is used by1 species as medicine or food.

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Qarabağın etnobotaniki təhlili

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Məqalədə Qarabağın etnobotaniki səciyyələndirilməsindən bəhs edilir. Aparılan sorğular və ədəbiyyat məlumatlarından məlum olmuşdur ki, ərazidə 101 növ dərman bitkisi, 44 növ yabanı qida - meyvə və giləmeyvə, 28 növ yabanı tərəvəz, 20 növ ətirli-ədviyyəli, 10 növ boyaq və 300-dən çox yem bitkisi insanlar tərəfindən geniş istifadə edilirmiş. Bəzi ərazilər (Şuşa, Xankəndi, Xocavənd) barədə məlumatlar köçkün və qaçqın düşmüş yerli icmalardan alınsa da, Tərtər və Bərdə rayonları tam təftiş edilmiş, Fizuli, Ağdam və Ağcabədi rayonlarının bəzi kəndlərindən bitkilər toplanılmışdır. Toplanılan faydalı- dərman, qida və texniki bitkilər eyniləşdirilmiş və istfadə tezliklri müəyyənlşdirilmişdir. Tədqiqat zamanı müasir və klassik etnobotaniki metodikalarla bitkilərin istifadə yolları təyin olunmuşdur. Tədqiqatların davamı üçün müharibənin törətdiyi fəsadların aradan qaldırılması gözlənilir.

Açar sözlər: *Qarabağ, flora, dərman və qida bitkiləri, etnobotanika*

Этноботанический анализ Карабаха

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В статье представлена этноботаническая характеристика Карабаха. Исследования и литературные данные показали, что в регионе широко используются 101 вид лекарственных растений, 44 вида дикорастущих растений - фруктов и ягод, 28 видов дикорастущих овощей, 20 видов пряно-ароматических растений, 10 видов красильных и более 300 видов кормовых растений. Хотя информация по некоторым районам (Шуша, Ханкенди, Ходжавенд) была получена от местных общин временных переселенцев и беженцев, Тертерский и Бардинский районы были исследованы полностью. Также были собраны растения в некоторых селах Физулинского, Агдамского и Агджабадинского районов. Собранные лекарственные, пищевые и технические растения были идентифицированы и определена частота их использования. В ходе исследования были определены способы использования растений современными и классическими методами этноботаники. Для проведения дальнейших исследований следует ожидать предотвращения последствий войны.

Ключевые слова: *Карабах, флора, лекарственные и пищевые растения, этноботаника*

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Prospects for studyıng bats of Karabakh as part of the Lesser Caucasus fauna

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The article highlights the gap in studying the bat fauna in Mountainous-Karabakh and adjacent areas within the Lesser Caucasus as no research studies were conducted in this part because of the prolonged territorial occupation. Comparative description of bat fauna is being provided between Mountainous-Karabakh and the Nakhchivan Autonomous Republic (AR) which reveals a close faunal similarity, one of the reasons of which is the local movements of bats between these sides. Nine species of regional bat fauna (19 species or 58% of local bat fauna) carry local conservation status. Most species tend to decline in global populations. The importance of studying the bat fauna of the Lesser Caucasus, including the bats in Karabakh, in more modern approaches and using stationary and mobile detectors which are already being applied in house by the author as well as other modern equipment (using acoustic and remote tracking methods) remains necessary for studying certain ecological peculiarities of bats. This article presents echo spectrograms of four bats as examples.

Keywords: *Lesser Caucasus, bats, chiropterofauna, biodiversity, new methods*

INTRODUCTION

Mountainous Karabakh covers the mountain ranges of Murovdag and Karabakh, as well as the Karabakh Volcanic Massive and the Valley of Central Aras-Nakhchivan and forms the south-east edge of the Lesser Caucasus Natural Provinces within Azerbaijan. In general, the Lesser Caucasus is being characterized by a shortage of forests (Прилипко, 1970) and that its vertical belts are relatively even (except for the Murovdag and Zangazur). The climate is dry continental; the river system is not well established. The arid zone covers the skirts of the abovementioned ridges as well as the entire Nakhchivan Valley to the west direction. Anthropogenic factors have contributed to the transformation of natural landscapes, and over the last 30 years, and this process has negatively impacted the environment even faster and more purposefully.

The territory of the Nakhichevan AR is characterized by an exceptional wealth of natural conditions (Babayev, 1999). A wide variety of relief, landscapes, climate, flora and fauna has always attracted the attention of specialists of different profiles. Due to a peculiar geological history, the northern outpost of the Middle East formation Center arose and is located here. This is the reason for the high level of endemism of the flora and fauna of this south-eastern edge of the Lesser Caucasus. In recent 15-20 years, significant changes have occurred in this area due to the intensification of infrastructure, industry and agriculture, the use of chemical means to combat various pests, the creation of new protected areas, border conflicts (Talıbov, 2001).

The Lesser Caucasus owns 33% of all karst square (6000 sq. km) existing in Azerbaijan. The largest karst caves such as Azykh, Taghlar, Shusha, Daghtumas, Tugh etc. (having 240 caves with total lengths of 4km) are in Nagorno Karabakh. The local conditions provide convenient natural (rocky cliffs, caves, tree hollows, etc.) and manmade shelters (wells, buildings, mines, mining tunnels, etc.).

The Mountainous Karabakh area remains unstudied over the last 40 years and is considered as

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a gap for a faunal overview of the overall Natural Province within Azerbaijan. The investigation of the Nakhchivan AR bat fauna occurred recently (Raxmatulina, Həsənov 2009) when analogical research studies are not applicable to the bat fauna of Mountainous Karabakh (seven long-term occupied surrounding districts) and the available info in this sphere dates back to the before 1980's (Сатунин, 1912; Верещагин, 1959; Гаджиев, 1967; Дубовченко, 1969; Алекперов, 1966; Алекперов, Рахматулина, 1975); Фаттаев, 1978; Рахматулина, 1970, 1980, 2005).

In addition to the changed natural conditions that occurred over time, we assume that still unknown to us various anthropogenic changes that occurred during the occupation period have not gone beyond the bat fauna. Considering the time difference and the changes it is important to re-explore the bat fauna in Karabakh as an integral part of regional biodiversity. It also should be noted that the Lesser Caucasus bat fauna is the least studied compared to other natural provinces in Azerbaijan. Scientific literature also contains no or occasional information on bat species inhabiting the regions such as Gedabek, Dashkesen, Goygel, Goranboy, Tartar, Ganja and its surroundings. Over the last 40 years, no required research studies have been carried out in the territories of Nakhchivan and the Lesser Caucasus bordering with the former front line as well as Armenia as it was not safe. In view of all of this, for the detailed study of the Lesser Caucasus chiropterofauna within Azerbaijan, there is a need for deeper investigation of bats in Mountainous Karabakh covering about 30% of all mammal species via application of newer technology/methodologies.

To understand the work scope of bats fauna investigation in the Lesser Caucasus we have compared in this paper the faunal composition of Nakhchivan (own investigation data for 2006-2008, 2013 years) and Mountainous Karabakh with surrounded territories (based on literature data dated back to 1880s). Along with a comparative study of chiropterofauna, it also provides a general impression of how rich the bat fauna is in these two areas with a distinct specific climate and orographic conditions.

MATERIALS AND METHODS

Field surveys and collation of materials in Nakhchivan AR were conducted in 2006-2008 jointly with Dr. I.K.Rakhmatulina and in 2013 independently.

The study area mainly covered the central and eastern regions of Nakhchivan, ranging from the distinctive semi-arid landscape of the Aras valley up to the alpine meadows. The main target was to revisit already known bat shelters, colonies as well as to reveal new roosts (hibernation sites, summer shelters). Over the study period we have recorded 14 bat species, 153 individuals captured (Mehely's and greater horseshoe bats, lesser mouse-eared bat, brown long-eared bat, eastern barbastelle, Schreiber's bent-winged bat) were banded and released back to nature.

Generally accepted methods of observation and counting were applied during the field surveys (Кузякин, 1950; Громов, Гуреев, 1963; Horacek et al., 2000; Kunz et al., 1996). Via using the ultrasound detectors, we have recorded many synanthropic bat species among which the predominant ones were common and Kuhl’s pipistrelles. This article also covers the materials from collections of ANAS Institute of Zoology, the Zoological Museum of Moscow's State University, and the Russia Institute of Zoology (based on Rakhmatulina, 2005). We physically inspected those areas (natural and manmade structures) which could potentially be suitable as summer or winter roosts for bats. All captured individuals were identified to species level, age, sex and reproductive status were determined, measured (weight, length of body, forearm, and tail), banded and released back. Daytime surveys were based on visual observations (shelter designation), and night surveys on field-routes with active bat detectors (Pettersson D200). Bats were recorded directly in their shelters or captured and identified with nets. All methods were aimed at determining the species composition of bats and compiling the transect records on the flight intensity of bats.

Bat fauna composition related info is based on only literature materials dated back to 1980s (Рахматулина, 2005).

RESULTS AND DISCUSSION

Mountainous Karabakh territory is well known for its karst caves as it is mentioned above. Only Azykh (located in the border of Khojavend and Fizuli districts) being the biggest in the Caucasus and 5th globally largest karst cave is home to 6 species of bats (*Rhinolophus ferrumequinum, R. mehelyi, Myotis blythii, Miniopterus schreibersii, Plecotus austriacus, and Barbastella leucomelas*), the largest karst cave in the southern Caucasus and the 5th largest karst cave in the world. The numerous and common species among them were Mehely's horseshoe bat (*R. mehelyii*) and Schreiber's bent-winged bat (*M. shcheribersii*). The number of individuals of both species reaches up to 10-30 thousand. Each species depending on the physiological condition as well as the time of year occupies the various halls and parts of the cave. I.K. Rakhmatulina reviewed and consolidated all available for the last 100 years literature data, various collection materials as well as own long-terms scientific research results related to the bat fauna of Nagorno Karabakh (Сатунин, 1915; Верещагин, 1959; Кузякин 1950; Дубовченко 1968, Алекперов, 1966, 1968; Алекперов, Рахматулина, 1975) in own scientific papers and particularly in her final monography (Rakhmatulina 2005). This list consists of 19 species with the following split per genus: 5 *Rhinolophus* – 5, *Myotis* – 4, 1 (*Miniopterus* – 1, *Plecotus* – 1, *Barbastella* – 2, *Nyctalus* – 1, *Pipistrellus – 3, 1 Hysugo* – 1, *Eptesicus* – 1 və *Tadarida* – 1. This composition has close similarity with the Nakhchivan bat fauna (16 species) which is being described later in this paper (Raxmatulina, Həsənov, 2009).

Bat species composition varies vertically. On the foothills the common and Kuhl's pipistrelles are numerous, greater horseshoe bat and serotine bat are common. The richest bat fauna belongs to the middle mountainous zone of 600-1000 m above sea level, where more than 10 bat species are common or numerous. Horseshoe bats, lesser mouse-eared bat, Schreiber's bent-winged bat, Kuhl's, Savi's, common pipistrelles are species-indicators. A number of speleofil species form bigger colonies. Colonies with more than 10 thousand individuals of 4 species were registered in Taghlar, Tugh, Azykh caves and 11 species in Shusha Dashalty (Рахматулина, 2005). This kind of diversity and richness is due to both food availability (entomofauna) as well as the existence of suitable sheltering conditions during various seasons of the year. At an altitude of 1000-2000m, the population number of species decreases (3 numerous and 5 common species) in spite of the fact that the number of bats species is still 19. The minimum number of species is in the zone above 2000 m.

Nakhchivan AR - 16 bat species which were registered by us (physically and recording via ultrasounds) in the territory of the Nakhchivan AR in 2006-2008, 2013 belong to 3 families: Rhinolophidae (5 species), Miniopteridae (1) and Vespertilionidae (10).

Representatives of these families include 8 species throughout the territory - lesser horseshoe bat (*Rhinolophus hipposideros*), greater horseshoe bat (*R.ferrumequinum*), Schreiber's bent-winged bat (*Miniopterus schreibersii*), lesser mouse-eared bat (*Myotis blythii*), common pipistrelle (*Pipistrellus pipistrellus*), *P. pygmaeus*), Kuhl's pipistrelle (*P. kuhlii*), serotine bat (*Eptesicus serotinus*) and form the main species of fauna (Table 1).

During the field surveys, key attention was drawn to underground shelters (caves, mining tunnels). Synanthropic inhabitants of urbanized areas were registered and counted during evening fly out from the shelters as well as on the pathways and foraging sites. In addition, more detailed data was collected on the shelters, population number and age-sex composition of speliophil species such as *R.ferrumequinum*, *M. blythii*, *M. schreibersii*.

Extremely rare bat species include the mediterranean horseshoe bat and Blasius's horseshoe bat (*R.euryale* and *R.blasii*), and the brown long-eared bat (*Plecotus auritus*), the individual of which were captured in Ordubad and Shahbuz districts since the beginning of the 20th century. Two young males of the latter species were captured by us on October 20, 2006, in the Turkesh village of the Shahbuz district.

From recorded for the first time 4 bat species in the Nakhchivan AR - whiskered bat and Geoffroy's bat (*Myotis mystacinus*, *M.emarginatus*), soprano pipistrelle (*Pipistrellus pygmaeus*) were identified by ultrasound in Nakhchivan city and the Kotam village of the Ordubad district. Given the widespread distribution of these species throughout Azerbaijan, the same situation can be expected in the Nakhchivan AR. The dead body of another

new species, *Hypsugo savii*, was found in October 2006 in the village of Kalaki, Ordubad district.

The number of speleofil bat species here in different seasons ranged from 120 individuals for *R. ferrumequinum*, up to 60 for *R. mehelyi*, more than 500 for *M. blythii*, and up to 500 for *M. schreibersii*.

The largest breeding colony of *M. blythii* and *M. shreibersii* was revealed in the "Bat's Nest" cave in the Bilav village of the Ordubad district (Figure 3) with the total number of individuals of more than 1,000.

It was impossible to monitor the border zone of the Nakhchivan AR with Armenia – this is the site where the Kotam-Kilit cave system which is home to a number of the priority species such as Blasius's horseshoe bat, mediterranian horseshoe bat and greater horseshoe bat as well as the eastern barbastelle is located. It should be noted that more interesting groups of bats, as well as large breeding colonies of Schreiber's bent-winged bat and Lesser mouse-eared bat species, are inhabiting the Ordubad National Park.

Unfortunately, the Maralik Cave in the Shahbuz district, one of the dynamic shelters and previously recorded for Blasius's horseshoe bat, mediterranean horseshoe bat, greater horseshoe bat (10) has lost its important role as a shelter for bats after being used by shepherds.

Among the explored shelters, it is important to highlight the Sirab Cave. This place is known as the wintering roost for horseshoe bat species (*R. mehelyi*, *R.ferrumequinum*), which have been protected since the middle of the XX century. The first species has not yet been obtained, however, in summer and autumn seasons the Schreiber's bent-winged bat and the lesser mouse-eared bat become very common here. This cave is one of the main bat shelters in the central part of Nakhchivan AR. It is recommended to protect this site by declaring it a natural monument. It is recommended to give similar status to the "Bat's Nest" cave (Figure 3) in Bilav village of Ordubad district. This cave is a shelter for large breeding colonies of two locally and internationally protected species - *M. blythii* and *M. schreibersii.*

Similarity between Mountainous Karabakh and Nakhchivan bat faunas. Via comparing species composition of both areas' bat fauna it was revealed very close similarity between them – 16 bat species in Nakhchivan and 19 in Mountainous Karabakh. Future comprehensive investigations would clarify and reveal a more precise composition for both areas. As shown in Table 1, nine of these species are registered in the 2nd edition of the Red Book of the Azerbaijan Republic. Only 6 of all bat species recorded are with the stable trend, 3 unknown, and only one with the increasing global population trend. The rest of the species have a decreasing population trend globally. Despite recording of *T. teniotis* (European free-tailed bat) only once near Shusha city back in 1950) there is a probability to register these species also in Nakhchivan and even the Greater Caucasus. Figure 1 is a schematic map of recorded bat locations in the Lesser Caucasus covering Nakhchivan and Karabakh.

Local seasonal movements (change of summer and hibernation roosts) occur between the caves of Nakhchivan and Karabakh caves (Rakhmatulina, Hasanov 2001).

Studying of bats by application of new methods. Bats have a hidden lifestyle, roosts are not easily reachable in most cases, hibernation and breeding colonies are very vulnerable to be disturbed, from health and safety perspective of known and emerging zoonotic diseases (Kuzmin, Bozick, et al., 2011; Hasanov, Guliyeva, 2020) it is necessary to reduce as much physical contact as possible with all wild animals including bats and it is recommendable to investigate various ecological aspects of bats by application of newer and remote methods particularly taking into account the uneven and difficult relief of the Lesser Caucasus. With the use of remote equipment, bat's ethology can be studied in detail such as long-distance migration as well as local movements between hibernation and summer roosts, patterns of pathways and foraging routes, etc. Stationary (passive) and mobile detectors can be used to determine the relative number and activity intensity of transects and stations. Recording and processing of ultrasounds with dedicated programs allow determining the species without capturing them physically. One of the priorities is to create an ultrasound library of the Lesser Caucasus's bats via obtaining spectrograms, specific for various species (Figure 2) and can be used for species determination remotely.

Table 1. Comparative composition of Karabakh and Nakhchivan Bat Faunas

N	Scientific name	Common name	Nakhchivan	Karabakh	Red Book	IUCN	Population Trend
1	*R. hipposideros*	Lesser horseshoe bat	+	+	+	LC	decreasing
2	*R. blasii*	Blasius's horseshoe bat	+	+		LC	decreasing
3	*R. euryale*	Mediterranian horseshoe bat	+	+	+	**NT**	decreasing
4	*R. mehelyi*	Mehely's horseshoe bat	+	+	+	**VU**	decreasing
5	*R. ferrumequinum*	Greater horseshoe bat	+	+	+	LC	decreasing
6	*M. blythii*	Lesser mouse-eared bat	+	+	+	**NT**	decreasing
7	*M. naterrerii*	Natterer's bat		+		LC	stable
8	*M. emarginatus*	Geoffroy's bat	+	+		LC	stable
9	*M. mystacinus*	Whiskered bat	+	+		LC	stable
10	*P. auritus*	Brown long-eared bat	+	+		LC	decreasing
11	*B. barbastellus*	Western barbastelle		+	+	**NT**	decreasing
12	*B. caspica*	Eastern barbastelle	+	+	+	LC	unknown
13	*N. noctula*	Noctule bat	+	+		LC	unknown
14	*P. pipstrellus*	Common pipistrelle	+	+		LC	stable
15	*P. kuhlii*	Kuhli's pipistrelle	+	+		LC	increasing
16	*H. savii*	Savii's pipistrelle	+	+		LC	stable
17	*E. serotinus*	Serotine bat	+	+		LC	stable
18	*M. shreibersii*	Schreiber's bent-winged bat	+	+	+	**VU**	decreasing
19	*T. teniotis*	European free-tailed bat		+	+	LC	unknown

Note: *Pipistrellus pygmaeus* has not been reflected in this list yet as it needs additional justification.

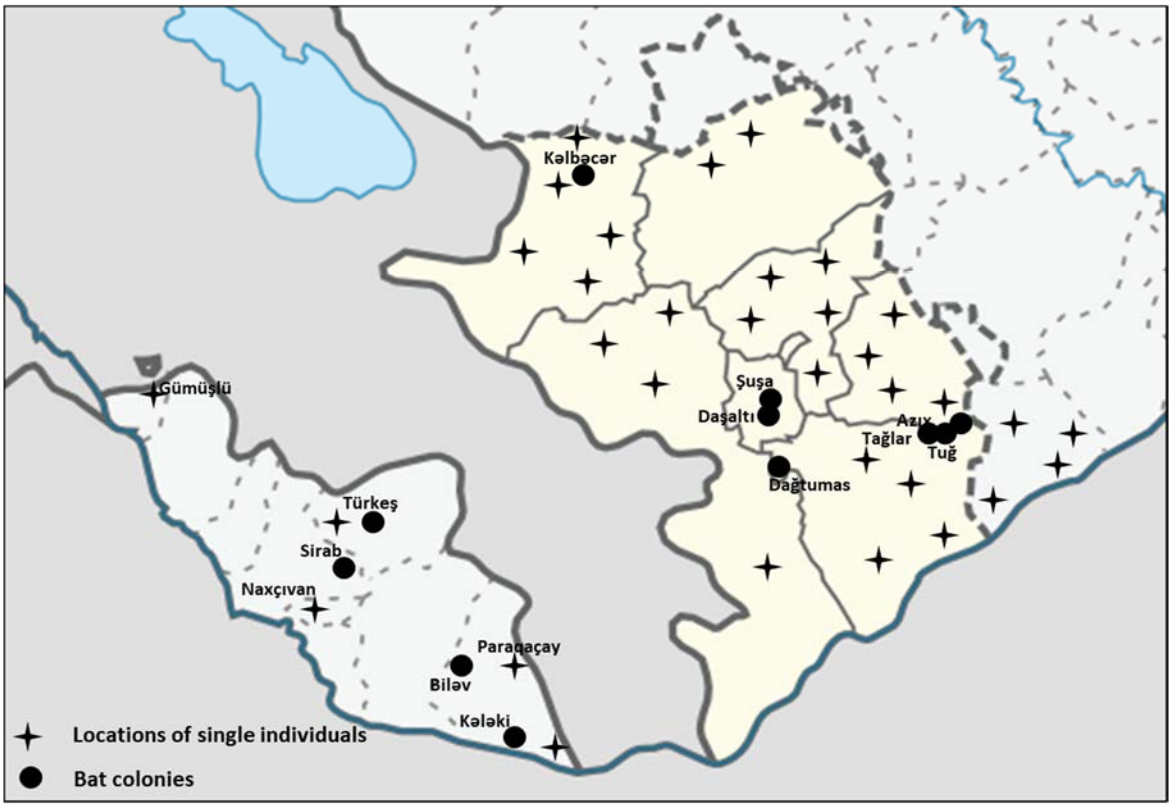
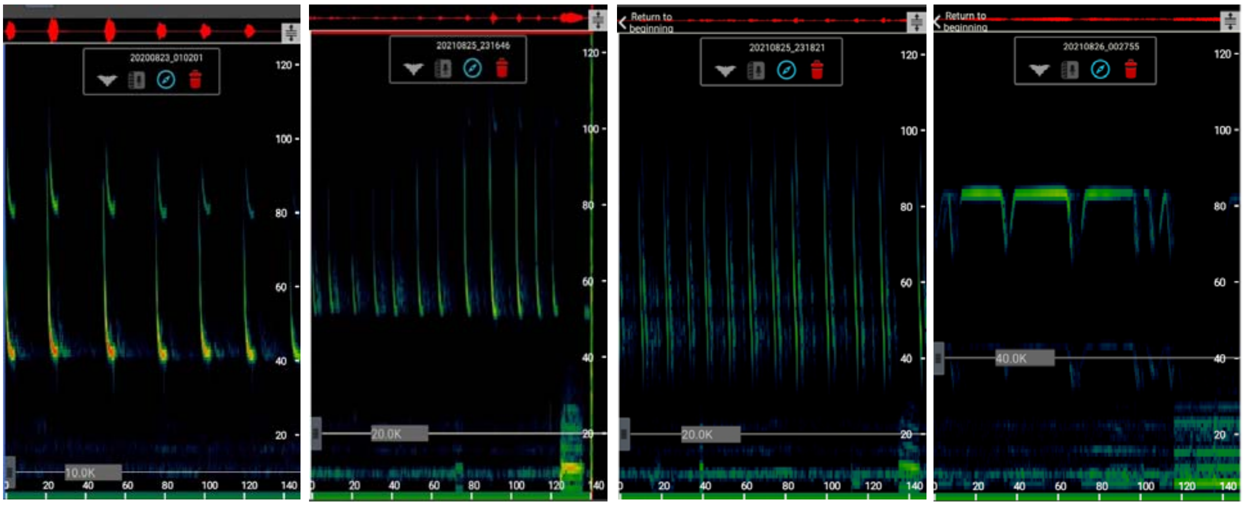


Fig. 1. Bat registration locations in the Lesser Caucasus - Nakhchivan (2006-2008, 2013) and Karabakh (literature data covering the period over 1900-1980)



Pipistrellus kuhlii ***Pipistrellus pipistrellus*** ***Myotis emarginatus*** ***Rhinolophus ferrumequinum***

Fig. 2. Spectrograms of four bat species obtained by echo-meters in the Lesser Caucasus.
Note: each spectrogram is specific to the species and recognizable particularly for the species from various genera



"Bat Nest", Bilav village, Ordubad district - 2009



Myotis blythii **individuals – Nakhchivan city - 2009**

Fig. 3. Photos of some bat species recorded in Nakhchivan

Application of passive detectors into the bat surveys has been started since 2020 in the Greater Caucasus. Remote control (distant) tools for the investigation of various ecological peculiarities of small size mammals including bats have not been practiced in Azerbaijan yet.

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Qarabağda yarasaların Kiçik Qafqaz faunasının tərkib hissəsi kimi öyrənilmə perspektivləri

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Məqalədə Kiçik Qafqazın yarasalar faunasının təfərrüatlı tədqiqi perspektivindən Dağlıq Qarabağ və ətraf rayonların uzun müddət təddqiq olunmaması ucbatından bir boşluq kimi qaldığı vurğulanır. Ədəbiyyat məlumatları əsasında Dağlıq Qarabağ və müəllif tədqiqatları əsasında Naxçıvan MR xireptofaunasının növ tərkibinin müqayisəsi verilir və nə onlar arasındakı bənzərliyə diqqət çəkilir ki, bunun səbəblərindən biri də yarasaların bu iki ərazi arasında lokal yerdəyişmələrin olmasıdır. Region yarasalar faunasının (19 növ

və ya yerli yarasa növlərinin 58%-i) 9-növü yerli qorunma statusuna malikdir. Növlərin böyük əksəriyyətinin qlobal populyasiya trendi azalandır. Kiçik Qafqaz və o cümlədən Qarabağ xirepterofaunsının daha müasir üsullarla tədqiq olunması və ölkədə müəllif tərəfindən artıq tətbiq olunan stasionar və səyyar detektorlar, digər avadanlıqlar vasitəsilə yarasaların akustik və məsafədən izləmə metodları ilə bir-sıra ekoloji xüsusiyyətlərinin araşdırılmasının vacibliyi bildirilir. Dörd yarasa növünə aid exo-spektoqaramlar əyani nümunə olaraq məqalədə təqdim olunur.

Açar sözlər: *Kiçik Qafqaz, yarasalar, xirepterofauna, biomüxtəliflik, yeni metodlar*

Перспективы изучения летучих мышей Карабаха, как части фауны Малого Кавказа

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В статье указывается на существование пробела в изучении фауны рукокрылых Нагорного Карабаха и прилегающих районов в пределах Малого Кавказа, поскольку научные исследования в этой части не проводились из-за длительной территориальной оккупации. Дается сравнительное описание фауны летучих мышей Нагорного Карабаха и Нахчыванской Автономной Республики (АР), которое выявляет близкое фаунистическом сходство, одной из причин которого, являются локальные миграции летучих мышей между этими регионами. 9 видов региональной фауны рукокрылых (19 видов или 58% местной фауны летучих мышей) имеет местный охранный статус. Большинство видов имеют тенденцию к сокращению глобальной популяции. Внедрение более современных подходов в изучении фауны летучих мышей Малого Кавказа, в том числе летучих мышей Карабаха, с использованием стационарных и мобильных детекторов, которые уже применяются автором, а также другого современного оборудования с акустическим и дистанционным методами слежения, остается важным и необходимым условием для изучения целого ряда экологических особенностей летучих мышей. В качестве наглядного примера в статье представлены экзоспектрограмы четырех видов летучих мышей.

Ключевые слова: *Малый Кавказ, летучие мыши, хиреnтерофауна, биоразнообразие, новые методы*

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The study of *Scutellaria* L. sect. *Lupulinaria* A. Hamilton (*Lamiaceae*) in Karabakh

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The article examines the study of the *Scutellaria* L. sect. *Lupulinaria* A. Hamilton (Lamiaceae) in Karabakh and adjacent regions. The herbarium specimens of BAK as well as various virtual herbaria samples collected in 1900-2020 have been analyzed to understand the status of research related to the genus *Scutellaria*. In addition, the species of the genus Scutellaria occurring in Azerbaijan and neighboring countries have also been compared by using a systematic review of relevant literature. According to the floristic study of the *Scutellaria* L. sect. *Lupulinaria* A. Hamilton in Karabakh, it is concluded that they have been poorly investigated since the second half of the twentieth century. The species have not been studied recently, last 30-40 years, so their systematics is required to be investigated comprehensively. At the same time, opinions and comments are given on the study of *Scutellaria* species of the region soon after the liberation of those areas from Armenian military occupation.

Keywords: *Scutellaria, herbarium specimens, skullcup, Karabakh, Azerbaijan*

INTRODUCTION

The Karabakh region is an eastern part of the Lesser Caucasus distinguished by its climate and landscape diversity, including mainly the mountainous areas and intermountain lowlands. It is bounded on the northwest by the Murovdag Range and on the north by Incechay Range, on the northeast by the Karabakh Plain and the east by Mill Plain, on the west by the Karabakh Range, and the southwest by Lachin, Gubadli, and Zangilan administrative districts; from the south, it extends to the state border with the Iran Islamic Republic through the territories of Jabrayil, Zangilan and Füzuli administrative districts (Səlimov, 2021). According to the botanical-geographical regionalization of Azerbaijan, mainly it covers the central and southern part of the Lesser Caucasus (Fig. 1).

The study of the flora of Karabakh and Zangazur is closely related to the expeditions conducted at different times in the region to study the flora and nature of the Caucasus in general. The systematic review of relevant literature and especially the study of herbarium specimens collected from the Karabakh and Zangazur which were kept in various Herbarium collections all over the world displays that the first botanic expeditions to the area were undertaken by A.I.Shovich (1829), later followed by R.F.Hohenacker, F.A.Bushe, G.I.Radde, Y.S.Medvedev, V.I.Lipsky, A.A.Lomakin, B.B.Hryniewiecki and others (Еленевский, 1965).

After 1917, in addition to the floristic researches in Karabakh and Zangazur areas, several geobotanical studies were carried out to study the vegetation of forests and pastures. The botanical explorations of mountain xerophytes in the southern part of the Lesser Caucasus were carried out by A.A.Grossheim, I.I.Karyagin, T.Heideman, L.I.Prilipko, etc. in 1928-1935. Scientists have studied the southern and western shores of Lake Goycha in 1928-1929, Karabakh in 1930 (especially surroundings of Shusha), the highlands of Kalbajar in 1931, as well as the Lachin Mountains (up to Minkend village), Khojavend region including the neighborhood of Mount Ziyarat in 1935 (Гейдеман, 1940).

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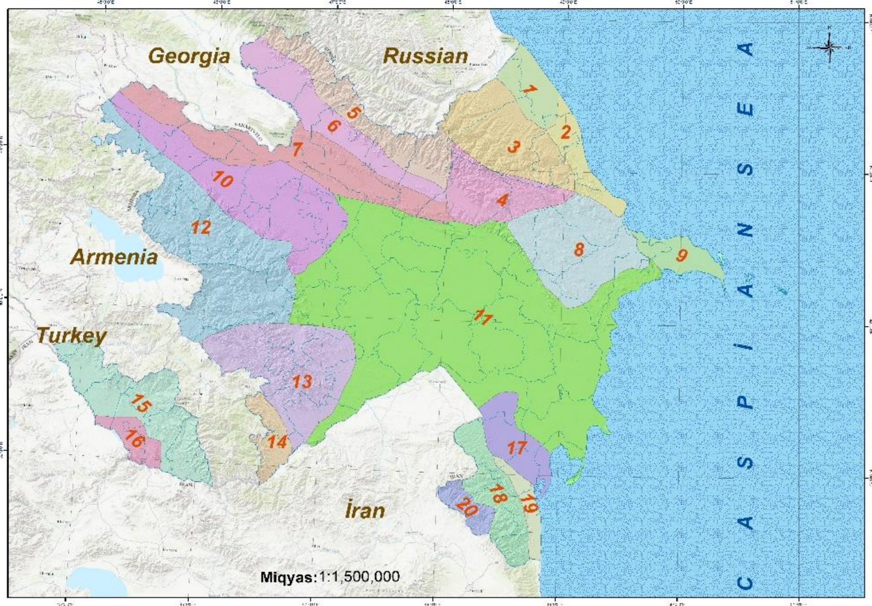


Fig. 1. Map of the botanical geographical division of Azerbaijan (after Prilipko, 1960):
1 - Samur-Devechi lowlands, 2 - Caspian lowlands, 3 - Quba massif in the Greater Caucasus, 4 - Eastern Greater Caucasus, 5 - Western Greater Caucasus, 6 - Alazan-Ayrichay valley, 7 - Bozgir plateau, 8 - Gobustan, 9 - Absheron, 10 - Kur plain, 11 - Kur-Araz lowlands, 12 - Northern Lesser Caucasus, 13 - Central Lesser Caucasus, 14 - Southern Lesser Caucasus, 15 - Mountain part of Nakhchivan, 16 - Nakhchivan plain, 17 - Lankaran-Mugan, 18 - Mountain part of Lankaran, 19 - Lankaran lowlands, 20 - Diabar.
Source: *Salimov* et al. Plant & Fungal Research 1(1): 69-85. 2018

The contribution of Acad. A.A.Grossheim's study of the flora of the Caucasus and, in particular, the flora of Azerbaijan is huge and multifaceted. One of the exceptional merits of A.A. Grossheim was the collection, herbarization, and morphological-systematic study of *Scutellaria* species found in the Caucasus area, particularly in Azerbaijan flora. He gave an overview of the *Lupulinaria* Ham. section of the genus, based on the result of many studies conducted on Caucasian representatives. In this review, only 19 species were presented, including 16 species for the Caucasus and 3 additional species for adjacent countries, Iran and Turkey. However, in 1899, V. Lipsky recorded that there were only one species for the Caucasus – *Scutellaria orientalis* L. (Гейдеман, 1940).

The majority of the herbarium specimens from the region in the second half of the 20th century were collected and studied by F. Ahmadzadeh.

As a result of the Armenian military aggression and negative impact on the biodiversity and ecosystem of Karabakh and the surrounding areas with its rich vegetation, have been severely damaged. The analysis of herbarium specimens collected from the region and a systematic review of literature is an invaluable source for a comprehensive assessment of the damage to the flora of the zone. This research analyzes and reviews herbarium samples of BAK and various virtual herbaria on the learning and research related to Scutellaria collected in 1900-2020.

MATERIALS AND METHODS

Studies were carried out on herbarium materials of the *Scutellaria* L. in 2016-2021. Herbarium specimens are deposited at the herbarium of BAK, LE, and virtual herbaria of various institutions (GBIF.org, 2021) as well as other available literature (Флора Азербайджана, 1957; Флора Грузии, 1985; Флора Армении, 1980; Edmondson, 1982; Jamzad, 2002; Муртазалиев, 2009), and the results of monitoring carried out by authors in nature were analyzed. The distribution and general area of the species were based on the Flora of Azerbaijan (Флора Азербайджана, 1957).

RESULTS AND DISCUSSION

The genus *Scutellaria* L. is one of the largest genera of Lamiaceae with more than 360 species worldwide. This genus is widespread in the foothills and mountainous areas of temperate regions, where the Mediterranean and the Caucasus as well as Iran-Turanian regions and Central Asia are considered to be the main centers of the genus biodiversity (Paton, 1990).

Scutellaria is represented by 15 taxa of which 4 species (*S. prilipkoana* Grossh., *S. grossheimiana* Juz., *S. rhomboidalis* Grossh. and *S. darriensis* Grossh.) are endemic to the flora of Azerbaijan. All these 4 species were described from Azerbaijan. To understand the significance of this study, the comparison of genus *Scutellaria* with the number of taxa in Azerbaijan and adjacent flora, the number of endemic taxa, and the rate of endemism are given in Table 1. It is seen obviously, the rate of endemism in countries close to the gene center is higher than the other countries (Salimov, 2018).

Table 1. The comparison of genus *Scutellaria* L. with the number of taxa in Azerbaijan and adjacent flora, the number of endemic taxa and the rate of endemism.

Countries and Regions	The number of taxa	The number of endemic taxa	The rate of endemism (%)
Flora of Azerbaijan	15	4	27
Flora of the Dagestan	8	2	25
Flora of Georgia	13	2	15
Flora of Armenia	8	0	0
Flora of Turkey	36	15	42
Flora of Iran	27	8	30

Approximately 87% of the genus specimens in other words individuals of 13 species are represented in the herbarium Fund (BAK) of the Institute of Botany of Azerbaijan National Academy of Sciences with occurrence data. The collection also contains type samples. As a result of the revision of type specimens which are stored in the BAK, the genus *Scutellaria* (*Lamiaceae*) is presented by 8 authentications of four species described from Azerbaijan: *S. darriensis* Grossh. (1 types), *S. grossheimiana* Juz. (2 paratypus), *S.prilipkoana* Grossh. (1 specimen authenticum and 3 topotypes), *S. platystegia* Juz. (1 topotype).

Based on a systematic review of the literature, 4 species of Scutellaria L. (*S. orientalis*L., *S. sevanensis* Sosn. ex Grossh, *S. platystegia* Juz. and *S. sedelmeyerae* Juz.) were recorded in Karabakh and surrounding areas. 21% of about 280 specimens of *Scutellaria* L. stored in the BAK were collected from these regions, especially from the administrative districts as Zangilan (15 specimens), Lachin (10 specimens) and Shusha (8 specimens). Besides, there are specimens collected from Agdam, Khojavend, Jabrayil, Fuzuli, and Kalbajar. We identified herbarium samples of *S. platystegia* Juz. predominated (43 specimens) among these collections. *S. platystegia* Juz. is widespread on foothills and it was described by S.Yuzepchuk, based on an herbarium specimen collected by Y.N.Voronov near the village of Chaytumas, Gubadli district in 1911.

Table 2. The number of herbarium specimens of *Scutellaria* L. deposited at the different herbaria.

Institution and index herbarium	*Scutellaria platystegia* Juz.	*Scutellaria orientalis* L.
Georgian Academy of Sciences, Institute of Botany, National Herbarium of Georgia	11	1
Vascular Plants Herbarium of the Komarov Botanical Institute RAS (LE)	5	1
Moscow University Herbarium (MW)	10	1
Natural History Museum, Vienna - Herbarium W	-	7
Masaryk University - Herbarium BRNU	-	3
Herbarium Berolinense, Berlin (B)	-	1
Herbarium Senckenbergianum (FR)	-	1
Total	**26**	**15**

During the research, it became clear that most of the herbarium specimens were mainly collected by A.A.Grossheim and I.I.Karyagin in the first half of the twentieth century, and in the second half by F. Ahmadzadeh. In addition, there are also collections of T.Heideman, J.Gurvich, Y.Menitsky, Y.Voronov, and I.Isayev. Herbarium specimens of Scutellaria species from Karabakh and surrounding areas were last collected by F. Ahmadzadeh in 1986 from Zabukh village of Lachin and in 1991 from Darzili village of Jabrayil. These collections belong to *S. platystegia*Juz. and comprises 7 and 1 specimens, respectively.

According to the collections, most of them cover the 1930s and 1940s. These areas had been under occupation as a result of Armenian military aggression for the last 30 years. Therefore, after the liberation of those areas, they are needed to be explored comprehensively to re-collect new herbarium specimens. Consequently, as a part of our ongoing research, it is planned to organize expeditions to the administrative regions of the Karabakh zone for studying the representatives of *Scutellaria* broadly.

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Qarabağda *Scutellaria* L. *Lupulinaria* A. Hamilton seksiyasının (*Lamiaceae*) öyrənilməsi

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Məqalədə *Scutellaria* L. cinsinin *Lupulinaria* Ham. seksiyasının Qarabağ və ətraf ərazilərdə öyrənilməsi araşdırılmışdır. Cinsin tədqiqinin vəziyyətini müəyyən etmək məqsədilə BAK və müxtəlif herbari fondlarında saxlanılan, 1900-2020-ci illərdə regiondan toplanmış cinsə aid herbari nüsxələrinə dair məlumatlar təhlil olunmuşdur. Ədəbiyyat materialları əsasında Azərbaycan və həmsərhəd ölkələrin floralarında rast gəlinən taksonlar müqayisəli olaraq analiz edilmişdir. Qarabağda yayılan *Scutellaria* növlərinin floristik öyrənilmə tarixinin təhlili nəticəsində müəyyən olunmuşdur ki, XX əsrin ikinci yarısından etibarən bu regionun başlıqotu növləri zəif tədqiq edilmişdir. Bu növlərin son 30-40 ilə yaxın müddətdə öyrənilməməsi səbəbindən onların sistematikasınının inteqrativ yanaşmalarla tədqiq olunmasını tələb edir. Eyni zamanda, həmin ərazilərin erməni hərbi işğalından azad edilməsindən qısa müddət sonra regionda yayılmış *Scutellaria* növlərinin taksonomiyasına dair bir sıra sualların araşdırılmasına ilə bağlı fikir və mülahizələr verilir.

***Açar sözlər**: Scutellaria, herbari nüsxələri, başlıqotu, Qarabağ, Azərbaycan*

Изучение секции *Lupulinaria* A.Hamilton рода *Scutellaria* (*Lamiaceae*) в Карабахе

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В статье представлены данные по изучению секции *Lupulinaria* A. Hamilton рода *Scutellaria* L. (*Lamiaceae*) в Карабахе и сопредельных территориях. С целью исследования статуса рода был сделан анализ сведений гербарных образцов BAK и образцов, имеющихся в разных фондах, собранных в регионе в 1900-2020 гг. На основе литературных данных проводится сравнительный анализ таксонов, встречающихся в Азербайджане и сопредельных странах. Выявлено, что со второй половины XX века виды шлемников по данным флористического исследования *Scutellaria* в Карабахе слабо изучены. Невозможность изучения этих видов за последние 30-40 лет требует интегративного подхода к исследованию их систематики. Кроме того, представлены некоторые идеи и рассуждения по выявлению вопросов таксономии видов *Scutellaria*, которые распространились в регионе, вскоре после освобождения этих территорий от армянской военной оккупации.

***Ключевые слова**: Scutellaria, гербарные образцы, шлемник, Карабах, Азербайджан*

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Species diversity of reptiles in the landscapes of the Lesser Caucasus within Azerbaijan

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Every landscape zone of the Lesser Caucasus is distinguished by its own reptile species complex. Significant territories of the Lesser Caucasus within Azerbaijan are lowlands. More than 25 species and subspecies of reptiles (54.7% of local reptile fauna) are encountered in this zone. The majority of species inhabiting this landscape zone are xerobionts. All reptile species registered in the semi-desert have also been observed on the foothills. The middle mountainous zone is characterized by the presence of species such as *Anguis fragilis, Ablepharus bivittatus, Lacerta media, Darevskia raddei, D.armeniaca, Zamenis hohenackeri, Coronella austriaca, Montivipera raddei*. The representatives of the neighboring foothills do also exist here. In total, 20 species and subspecies have been registered in this zone, consisting of 47.6% of reptile fauna in the study area. The high-mountain zone owns less rich herpetofauna, the core of which is mainly composed of the Caucasian autochthons. Paralaudakia caucasia species enters this area from its surroundings. In total 6 species or 13.9% of the Lesser Caucasus's reptile fauna has been recorded here.

Keywords: *Lesser Caucasus, reptiles, herpetofauna, biodiversity, landscapes*

INTRODUCTION

The relief (landscape) forms of the Lesser Caucasus, including its Azerbaijan part, are split into - mountain ranges and massifs, on the one hand, and plains, on the other. Each of these landscapes is being characterized by its own reptile fauna, and therefore we will deep dive into their peculiarities in more detail.

The mountain system of the Lesser Caucasus in Azerbaijan is represented by ridges (ranges) towards the southeastern direction. These ridges form the Shahdag, Karabakh and Konguro-Alanghez mountain ranges (Geography of Azerbaijan Republic, 2014).

Ground volcanism has played a leading role in the formation of the present landscapes in particular parts of the Lesser Caucasus (southeastern) at the beginning of the manifestation of which is noted in the Late Sarmatian. Many areas of the Lesser Caucasus have more or less preserved volcanic relief of lava sheets and slopes of large volcanoes.

The high-mountain zone of the Lesser Caucasus range does not have continuous distribution as it is on the Great Caucasus. Relatively small areas of the high mountains are interspersed among mid-mountain areas. The Lesser Caucasus is predominantly a mid-mountainous territory (Geography of Azerbaijan Republic, 2014).

Several vegetation types (landscapes) are distinguished in the territory of the Lesser Caucasus: semi-desert, desert, foothill, steppes and upland xerophytes, arid woodlands, alpine meadows and meadow-steppes, forest vegetation (Prilipko, 1970).

The above-described various landscape patterns determine a significantly uneven distribution

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and a pronounced “lace of areas” peculiarity of a significant part of the animal species including reptiles inhabiting here.

In 1947, A.M.Alekperov studied the fauna of Nakhichevan AR (Nakhichevan, Kakhab, Zeynaddin, Julfa, Daridag); in 1948, he made a collection on amphibians and reptiles of Zangelan. He transferred his herpetological collections to the Zoological Institute of ANAS.

In 1950, A.M.Alekperov again conducted investigations in the Nakhichevan AR and surveyed all districts of the Republic via the transect methods. Based on the materials of this study as well as previous expeditions, he published the paper “Reptiles of the Nakhichevan ASSR”. In his next article called “Materials on studying of amphibian and reptile fauna of the Nakhichevan ASSR” (1954) beside the personal materials of the collection of the Nakhichevan State Pedagogical Institute were also used (Alekperov, 1954).

In 1955-1960, I.S. Darevsky worked in the Nakhichevan AR, who for the first time revealed *Psammophis lineolatus* (Darevsky, 1967).

In 1955, A.M.Alekperov organized an expedition for comprehensive studying the amphibian and reptile fauna of Azerbaijan. The survey was conducted on the Eastern slopes of the Lesser Caucasus (Khanlar region, Adjikend, Chaikend, Lake Gek-gel) and Garabagh. Huge efforts were invested by A.M.Alekperov into the study of the batracho-herpetofauna of Azerbaijan resulted in the publication of his monography - “Amphibians and Reptiles of Azerbaijan” (1978).

Studies of T.A.Aliev (1974) are devoted to the ecology and distribution of venomous snakes of the Nakhichevan AR. S.B.Akhmedov (1981) studied skinks of the Lesser Caucasus. S.G.Jafarova studied ecology, distribution and conservation of the reptiles of the Lesser Caucasus (Alekperov and Jafarova, 1979; Jafarova, 1979; 1980). Due to the occupation of the territories of the Lesser Caucasus (Nagorno Garabagh and surrounding five districts) by the Armenian invaders, field surveys stopped since the 1980s.

S.N.Bunyatova surveyed the eastern slopes of the Lesser Caucasus in 2015-2020 years (Bunyatova, 2020).

MATERIALS AND METHODS

This research is based on materials collected by S.G.Jafarova over the period of 1974-1980 and by S.N.Bunyatova in 2015-2020 years. S.G.Jafarova worked in the Upper Garabagh, Garabagh volcanic plateau and Hakari physical-geographical regions, as well as S.N.Bunyatova surveyed Ganja physical-geographical region and Nakhichevan AR.

All available herpetological literature and collection of reptiles in the repositories of the Department of Vertebrate Zoology at the Baku State University and herpetological collection at the Institute of Zoology of ANAS were used as well.

Collecting of materials in the field and their laboratory processing were conducted by application of generally accepted methodologies (Bannikov et al., 1977).

Counting on tape samples (along transects) was carried out according to the methodology of L.G. Dinesman and M.L. Kaletskaya (1952), with some modifications. The counts were carried out visually along path (walking) routes and at stationary sites, mainly during the period of maximum activity of reptiles in the spring and summer seasons.

All collected materials are preserved in the collection fund of the Department of Vertebrate Zoology at the Baku State University.

RESULTS AND DISCUSSION

The modern landscape of the Lesser Caucasus has been generated a long way of complex geological development. In its structure, along with folded ridges, chains of volcanic peaks and extensive subsidences, which have the patterns of either high plateaus formed by flows of solidified lava and upland basins, or representing vast plains lowlands, are involved.

Concerning the history of the formation of the mammal fauna of the Caucasus, N.K. Vereshagin (1959) indicated that it was inextricably linked with the history of the development of the Caucasian land, its flora of landscapes, with the development of the life forms and ranges of certain animal species. The formation of landscapes was influenced by the impact of transgressions and regressions of the seas, mountain-building processes and glaciations. According to I.S. Darevsky (1967),

"….one can only speculate about the species composition of the primary nucleus of the Caucasian herpetofauna, but the picture of the distribution of this fauna should be considered as a consequence of changes in the primary habitats as a result of intense mountain-forming processes and under the influence of glaciers."

At the present, each landscape zone of the Lesser Caucasus is being characterized by its own reptile species complex, formed as a result of long-term historical processes of these areas formation.

On the territory of the country, large areas are occupied by low-lying semi-deserts, which are characterized by wormwood-saltwort and saltwort semi-shrub communities. More than 25 species and subspecies of reptiles are inhabiting here. These are *Testudo graeca, Trapelus ruderatus, Paralaudakia caucasia, Phrynocephalus horvatii, Trachylepis septemtaeniata, Eumeces schneiderii, Eremias strauchi, Lacerta strigata, Xerotyphlops vermicularis, Eryx jaculus, Platyceps najadum, Dolichophis schmidti, Hemmerrhois ravergieri, Eirenis collaris, E.modestus, E.punctatolineatus, Rhynchocalamus melanocephalus, Telescopus fallax, Psammophis lineolatus, Malpolon insignitus, Vipera lebetina.*

A significant number of species of the analyzed landscape zone belong to xerobionts. *Trapelus ruderatus, Trachylepis septemtaeniata, Xerotyphlops vermicularis, Rhynchocalamus melanocephalus, Psammophis lineolatus* and to the lesser extent, *Ophisops elegans* and *Eryx jaculus* are characterized by linkage to untouched virgin habitats. The rest of the species have been adapted to a wide range of biotopes in both natural and anthropogenic complexes. Xerophytization of landscapes is largely occurring due to human economic activity, enabling some of these species to reclaim new habitats, settling within the area. For example, *Eremias strauchi* inhabiting on dry clay-gravelly slopes of mountains with shrubby xerophytic vegetation rises up to 1400-2000 m, *Eumeces schneiderii* – up to 1000 m and *Paralaudakia caucasia* by intrazonal habitats – up to 2000-2500 m above sea level.

In addition to this zone, the following landscape zones are distinguished in the Lesser Caucasus: *lower* – foothills, *middle* – middle mountains and *high* – high mountains. The foothills consist of landscapes, which are similar to the underlying plains. Landscape-forming grouping of plants is wormwood formations, rising to an altitude of 400-500 m, and in the Nakhichevan Autonomous Republic up to 1200-1400 m above sea level; arid woodlands, which include *Rhamnus pallasii, Paliurus spina-cristi, Berberis* sp., *Juniperis* sp., etc.

All reptile species inhabiting the foothills have been recorded by us in the lowland semi-desert. Particular attention was drawn to the mutual penetration (transition) of certain reptile species into the neighboring landscape zones. River valleys and canals of irrigation systems, as well as a dense road network, have an important role in reptile settlements. Thus, *Mauremys caspica, Eumeces schneiderii, Eryx jaculus* and *Macrovipera lebetina* penetrate into the mountain-steppe zone along the river valleys flowing into the Araz River. *Lacerta strigata* settles along the roadsides and fields into the semi-deserts, where it forms settlements of the "oasis" type. *Testudo graeca* and *Pseudopus apodus* from the deforested xerophytic slopes of the mountains ascend to the middle mountains zone.

The middle mountain zone is characterized by the presence of species such as *Anguis fragilis, Ablepharus bivittatus, Lacerta media, Darevskia raddei, D.armeniaca, Zamenis hohenackeri, Coronella austriaca, Montivipera raddei*. There are also representatives of the neighboring foothill zone: *Testudo graeca, Paralaudakia caucasia, Pseudopus apodus, Natrix tessellata, N.natrix, Platyceps najadum, Dolichophis schmidti, Telescopus fallax*. In total, 20 reptile species and subspecies have been registered in the middle mountain zone, and it consists of 47.6% of the overall reptile fauna of the study area. *Ablepharus bivittatus, Darevskia armeniaca, Zamenis hohenackeri, Coronella austriaca* adhere to the mountain zone and adjacent territories of gorges and ravines, rocky areas on the mountain slopes covered by bushes. *Darevskia portschinskii* and *D.rostombekovi* adhere to rock outcrops and its foothills with xerophilous vegetation. *Montivipera raddei* stays mainly on the edges of oak forests.

The alpine zone is more monotonous. It is composed of the uppermost parts of the forest belt, the belt of subalpine shrubs, subalpine and alpine mountain-meadow plant groups.

Table 1. Vertical distribution of reptile species of the Lesser Caucasus within Azerbaijan

N	Species and subspecies	Population number	Plains and foothills 200-600 (850) m	Middle mountains 1000-1500 (2000) m	High mountains 2000-2300 (2500) m
1	*Mauremys c.caspica*	common	+	+	-
2	*Emys orbicularis*	common	+	+	-
3	*Testudo g.ibera*	common	+	+	+
4	*Trapelus r.ruderata*	rare	+	+	-
5	*Paralaudakia c.caucasica*	common	+	+	+
6	*Phrynocephalus horvatii*	rare	+	+	-
7	*Pseudopus apodus*	numerous	+	+	-
8	*Angius f.fragilis*	common	-	+	-
9	*Trachylepis septemtaeniata*	rare	+	-	-
10	*Eumeces schneiderii*	common	+	+	-
11	*Ablepharus bivittatus*	rare	-	+	-
12	*Eremias s.strauchi*	common	+	+	-
13	*Eremias pleskei*	rare	+	+	-
14	*Lacerta strigata*	numerous	+	+	-
15	*L. media*	common	+	+	-
16	*Darevskia r.raddei*	numerous	-	+	+
17	*D. portschinskii*	rare	-	+	-
18	*D. valentini*	rare	-	-	+
19	*D. armeniaca*	abundance	-	+	+
20	*D rostombekovi*	common	-	+	+
21	*Ophisops e.elegans*	numerous	+	+	-
22	*Xerotyphlops vermicularis*	common	+	+	-
23	*Eryx j.familiaris*	common	+	+	+
24	*Natrix n.natrix*	common	+	+	-
25	*N. n.perca*	common	+	+	-
26	*N. tessellata*	common	+	+	-
27	*Platyceps n.najadum*	common	+	+	-
28	*Dolichopis schmidti*	common	+	+	-
29	*Hemerrhois r.ravergieri*	common	+	+	-
30	*H. chernovi*	rare	+	+	-
31	*Zamenis h.hohenackeri*	rare	-	+	+
32	*Elaphe urartica*	common	+	+	-
33	*E. dione*	common	+	-	-
34	*Eirenis collaris*	common	+	-	-
35	*E.p.punctatolineatus*	common	+	-	-
36	*E.modestus*	common	-	+	-
37	*Coronella austriaca*	common	-	+	-
38	*Rhynchocalamus m.satunini*	rare	+	-	-
39	*Telescopus fallax*	common	+	+	-
40	*Psammophis lineolatum*	rare	+	-	-
41	*Malpolon insignitus*	common	+	+	-
42	*Vipera eriwanensis*	rare	-	+	+
43	*Vipera l.obtusa*	common	+	+	-
44	*Montivipera raddei*	rare	-	+	+

The core of the herpetofauna of the high-mountain belt is mainly built on the Caucasian autochthons – *Darevskia armeniaca, D. raddei, D.valentini* and *Vipera eriwanensis,* which are numerous or common here. Some locations here is being also reached by *Paralaudakia caucasia*. In total, six species were recorded here, or 13.9 % of inhabiting the study area of the Lesser Caucasus. The distribution of the reptile species along the vertical landscape belts is presented in Table 1.

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Kiçik Qafqazın Azərbaycan hissəsində yayılan sürünənlərin landşaftlar üzrə növ müxtəlifliyi

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Müasir dövrdə Kiçik Qafqazın hər bir landşaft zonası özünəməxsus sürünən növlərinin müxtəlifliyi ilə fərqləndirilir. Məlum olduğu kimi, ölkə daxilidə Kiçik Qafqaz ərazinin əhəmiyyətli hissəsi yarımsəhralarla örtülmüşdür. Sürünənlərin 25-dən çox növ və yarımnövü burada qeydə alınır (54,7%). Bu landşaftda yayılan növlərin əksəriyyəti kserobiontlara aiddir. Yarımsəhralarda qeydə alınan növlərin hamısı dağətəyi ərazilərdə də müşahidə olunmuşdur. Orta dağlıq *Anguis fragilis, Ablepharus bivittatus, Lacerta media, Darevskia raddei, D.armeniaca, Zamenis hohenackeri, Coronella austriaca, Montivipera raddei* kimi növlərlə xarakterizə olunur. Burada həmçinin dağətəyi zonanın növləri də qeydə alınır. Ümumilikdə orta dağlıqda 20 növ və yarımnöv sürünənə rast gəliniur ki, bu da tədqiqat zonasında yayılan növlərin 47,6%-ni təşkil edir. Yüksək dağlıq ərazilərin faunası nisbətən kasaddır. Bu qurşağın sürünənlər faunasının əsasını Qafqaz avtoxtonları təşkil edir. Bəzi yerlərdən buraya *Paralaudakia caucasia* növü də daxil olur. Burada cəmi 6 növ qeydə alınmışdır ki, bu da Kiçik Qafqazda yayılan növlərin 13,9%-ni təşkil edirlər.

***Açar sözlər**: Kiçik Qafqaz, sürünənlər, herpetofauna, biomüxtəliflik, landşaftlar*

Видовое разнообразие рептилий в ландшафтах Малого Кавказа в пределах Азербайджана

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В настоящее время каждая ландшафтная зона Малого Кавказа характеризуется своим комплексом видов пресмыкающихся. Значительные территории Малого Кавказа в пределах республики заняты низменными полупустынями. Здесь сконцентрировано 25 видов и подвидов пресмыкающихся (54,7 % от общего количества в рассматриваемом регионе республики). Значительное число видов этой ландшафтной зоны относится к ксеробионтам. В предгорьях обитают все виды, отмеченные нами для равнинных полупустынь. Среднегорья характеризуются присутствием таких видов, как *Ablepharus bivittatus, Lacerta media, Darevskia raddei, D.armeniaca, Zamenis hohenackeri, Coronella austriaca, Montivipera raddei*. Здесь же встречаются и виды соседней предгорной зоны. Всего в зоне среднегорий зарегистрированы 20 видов и подвидов, что составляет 47,6% от всего их количества в рассматриваемом регионе. Высокогорный ярус более однообразен. Ядро герпетофауны высокогорного пояса слагается в основном из кавказских автохтонов. Поднимается сюда местами и *Paralaudakia caucasia*. Всего здесь зарегистрировано 6 видов, или 13,9%, населяющих исследуемую территорию Малого Кавказа.

Ключевые слова: *Малый Кавказ, рептилии, герпетофауна, биоразнообразие, ландшафты*

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Research on high genetic resources of oak forests in Karabakh and highlighting benefits of reconstruction of oak forests to our ecology and economic development

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The oak is an important part of our natural and cultural heritage. Oak trees had a special place in the formation of biodiversity in the rich flora of Karabakh. Thus, more than 35% of oak forests were distributed in the Lesser Caucasus, and 60% of the ecosystem of the Minor Caucasus is oaks. Of course, this information is based on pre-First Karabakh War data. At present, this percentage has changed, and the biodiversity of Karabakh and the Lesser Caucasus is under serious threat. The reason is the Armenian vandalism known to the world community. The biodiversity of oaks in Karabakh in the pre-occupation period was investigated, the environmental requirements of the species were noted for the restoration of existing oaks in these areas and the benefits of reforestation to the nature and economy of Azerbaijan were brought to attention in this review.

Keywords: *Karabakh, oak, afforestation, economic and environmental benefit*

INTRODUCTION

Oak has a special place in the formation of biodiversity in our country. Thus, oak trees take the third place in the formation of rich forest resources of Azerbaijan after beech and hornbeam (Aliyev et al., 2008; Mammadov and Khalilov, 2002). Oaks have a special symbolic, ecological, and economic value in our republic. The people of Azerbaijan have long regarded the oak tree as a symbol of strength, inflexibility, and longevity. When giving the initial draft of the state emblem during the Azerbaijan Democratic Republic in 1919-1920, oak branches were included in the national emblem symbolizing long-lasting and strong statehood as oak (http:www.anl.az). Therefore, the protection and research of oaks are of special importance for our statehood.

The goal of this article is to study the high genetic resources of oak forests in Karabakh in the pre-occupation period to restore biodiversity in Karabakh and to emphasize the benefits of the restoration of existing oak forests to our ecology and economy in the future.

Biodiversity and distribution area of oaks (Quercus ssp.) in Karabakh. Oak trees had a special place in the rich flora of Karabakh. Thus, more than 35% of oak forests were distributed in the Lesser Caucasus, and 60% of the ecosystem of the Lesser Caucasus consists of oaks (Mammadov and Khalilov, 2002). According to some authors, before the First Karabakh War, there were 5 species of oak in the flora of Karabakh (Bandin and Prilipko, 1964; Menitsky 2005; Mammadov and Khalilov, 2002; Asgarov, 2016; Mammadov, 2016):

Georgian oak (*Quercus petraea* ssp. *iberica* (Stev.)

Caucasian oak (*Quercus macranthera* subsp. *syspirensis* (K.Koch) Menitsky.)

Pedunculate oak (*Quercus robur* ssp. *pedunculiflora* (K.Koch) Menitsky)

Red oak (Qızılı palıd) (*Quercus rubra* L.)

Araz oak (*Quercus infectoria* subsp. *veneris* (A.Kern.) Meikle)

The given Latin names of the species are internationally accepted names (http: www.catalogueoflife.org). With the exception of red oak, the four species mentioned above are endemic to the Caucasus (Menitsky, 1970).

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Georgian oak. The distribution area of Georgian oak occupies the lower and middle part of the Lesser Caucasus mountain range. Georgian oak is found in Karabakh and Lachin regions (1400-1650 m) on the sloping forest strips on different slopes, as well as in Zangilan and Jabrayil regions on dry slopes and in the valleys, mainly in mixed forests (Menitsky, 1970; Mammadov and Khalilov, 2002). It grows under different climatic conditions, is a light-loving tree and is tolerant to drought, heat, and winter frosts (Selahattin, 2020). Georgian oak is not found in the plain regions of our republic, as this species cannot withstand temporary water stagnation and soil salinity. Under such conditions, Georgian oak is replaced by Pedunculate oak. This species is very suitable for planting roadside greenery. None tree species can replace Georgian oak on dry rocky mountain slopes (Ekhvaia, 2018; Bandin and Prilipko, 1964).

Caucasian oak. Caucasian oaks created high-yielding forests in the south-eastern part of the Lesser Caucasus in Lachin and Gubadli regions, low-moisture, various herbaceous oakery under juniper forest in the rocky slope over the Shaplar village in the Kalbajar region, on the left bank of Garadirnagchay in Kalbajar regions, oakery with steppe grass cover on the dry steep stony slope in Tursusu plateau of the Shusha region, and has created low-density meadow-steppe grass-covered hornbeam-oak ecosystems on a steep slope with low humidity near the village of Alkhasli. Caucasian oak forests are replaced by Georgian oak forests on the lower border, in the territory of the Lachin-Gubadli regions (Mammadov and Khalilov, 2002; Menitsky, 1970; Peter, 2014).

Caucasian oak is sometimes called "high mountain oak" because it grows in high mountains (Bandin and Prilipko, 1964). Caucasian oak can grow under different conditions. It can outlive in the coldest days and 30 degrees below zero, the need for heat is low, the need for moisture is moderate (Papını et al., 2011; Ekhvaia, 2018). The average annual temperature in the distribution areas of Caucasian oak is 1.8-6°C, the average annual rainfall is 600-1400 mm (Mammadov and Khalilov, 2002).

Pedunculate oak is involved in the formation of mixed forest formations in the south of the Lesser Caucasus, starting from the plains to 500-700 m above sea level (Menitsky, 1970). According to Agamirov, Pedunculate oak is the main forest-forming tree species in the Karabakh plain along the Kura-Araz. The oak forests in Karabakh were considered the main seed base of Pedunculate oak in Azerbaijan (Agamirov, 1961). The oak acorns collected from these forests were used in the creating of protective forest strips and forest massifs in the lower regions of the republic. Creates clean and mixed oak forests in plains and valleys (Agamirov, 1961, Bandin and Prilipko, 1964).

This species is drought-tolerant, light-loving. It loves heavy clayey, sandy, high water content soils. Moderately sensitive to autumn and winter frosts. Prefers plains, high groundwater areas, river valleys, does not like flows. Can grow in wet and humid places. Old trees are very resistant to flooding. Can grow in dry and dry sandy soils (Boratynski et al., 2008; Gabitova, 2012).

Araz oak is a part of the forests at an altitude of 500-1100 m on the southern slope of the Lesser Caucasus - Zangilan (Bargushadchay) and Gubadli regions. Araz oak is very drought tolerant and can be used for afforestation in the dry foothills and plains of the southern part of the republic (Bandin and Prilipko, 1964; Menitsky, 1970; Mammadov, 2016). Araz oak is included in the "Red Book" (Red book of Azerbaijan SSSR**,** 1989) as a rare and endangered plant species in Azerbaijan.

Red oak is found only in the Lachin region of Azerbaijan. Red oak was distributed in Azerbaijan only in the Hajishamli forest and Shelve gorge in the territory of Garagol State Nature Reserve and State Nature Reserve, located in the Lachin region (Lachin yurdu, 2014). Although there is not any information in scientific literature, a survey conducted among the local population of Lachin and an article published in the "Lachin yurdu" journal confirm this. Red oaks were covered more than 4,000 hectares in these areas prior to the occupation. Since the highest quality wine was made in barrels made of red oak, the Armenians after the First Karabakh War, cut down these forests en masse and carried them to France (Lachin yurdu, 2014).

Unfortunately, the nature and vegetation of Karabakh also got a share from Armenian vandalism. The enchanting nature has been destroyed and the area has become a ruin. The world community also witnessed that Armenian creatures, who did

not receive a share from humanity, burned the forests in Shusha using white phosphorus bombs in the last days of the Second Karabakh War. As in the whole Karabakh region, we have very rich and valuable forests in Shusha. The total area of the forest fund was 8,526 hectares before the occupation. Destruction of a unique ecosystem created by dense forests consisting mainly of valuable and perennial oak, juniper, beech, hornbeam, pine, ash-tree, walnut-tree, the vandal acts**,** which is a serious blow to mainly endemic biodiversity, all of these are considered a crime against humanity for all international environmental conventions to which Armenia is a party. The fires caused by white phosphorus bombs are impossible to put out, nor can they be extinguished naturally, and such fires last a long time.

Forming a new oakery. Oak species can be successfully used to restore the existing biodiversity in Karabakh. To forestall the loss of ecological values associated with forests, land managers need to consider where and when to prioritize active reforestation following major disturbance events (White et al., 2019). Direct seeding of acorns is generally more flexible than planting oak seedlings. If properly done, for example, direct seeding can be successfully accomplished any time of year. Direct seeding may be the only means available to establish oak stands on sites that are frequently flooded during winter and spring planting periods (Bullard et al., 1992). Laying of new oak strips should be carried out in an appropriate sequence and in a planned manner: site selection and preparation, planting, care, and protection (General Directorate of Forestry Strategic Plan 2017-2021, 2016). First of all, the soil needs of oaks should be taken into account. Oak grows in different soils. The largest area of oak is located in the dark brown, alkaline and light brown ash-mountain soils. A small area of oak is located in primitive soils, which turn brown and grayish-brown soils, in yellow river forests and other soils. Oaks do not like sour and saline soils (Bandin and Prilipko, 1964; Peter, 2004; Menitsky, 2005; Magnus et al., 2021, rastenievod.com). It should not be forgotten that the area to be planted has been turned into a steppe due to anthropogenic influences, the soil structure has changed, and as a result, the chances of success in afforestation are very low. Therefore, the soil must be brought into a form suitable for planting (Rural Environment, 2019). It is the responsibility of soil scientists to make proposals in this direction.

It is necessary to supply the latest acorns for planting, as acorns damaged by disease and pests shed more quickly (Fig. 1A) (Bandin and Prilipko, 1964). Collected acorns should be mixed by pouring them into tubs filled with water so that the acorns damaged by disease and pests will rise to the surface, and healthy cones will remain at the bottom of the water (Bandin and Prilipko, 1964). After discarding damaged acorns, healthy acorns are slightly dried in the shade and prepared for autumn planting. Acorns set aside for spring planting are stored in moist sand at a temperature of 0-3°C during the winter (rastenievod.com, Bandin and Prilipko, 1964) (Fig. 1B). It is better to bury the sprouted acorns in the spring in moist soil for planting. Spring planting completely eliminates the risk of freezing. The germination rate reaches 90-96% if the acorns are stored properly during the winter (Rural Environment, 2019, rastenievod.com). The oak acorns are often destroyed by wild boar, mice, and other rodents after being planted for reforestation. Seed sowing may be a cheap and efficient reforestation method that can yield high-quality seedlings for many woody species, but this option is usually discarded against seedling planting due to the high seed losses to mammal predators (Castro et al., 2015). It is recommended to smear acorns with zinc phosphide before planting to prevent them to be eaten by rodents. Acorns give good results when mixed with small crushed glass before planting. The surface of oak plantations must be covered with dried leaves, tree remains, and other materials under drought conditions (Bandin and Prilipko, 1964). Castro and his colleagues offered a new device to protect new seed sowings. They tested the effectiveness of a new device to prevent small mammals from consuming large seeds such as acorns and its effect on initial seedling performance. The device consists of a capsule made of two truncated pyramids joined at the bases, with two small openings at the top and the bottom where the stem and root can exit but rodents cannot enter. They conducted a field seed-predation experiment using fenced plots (only rodents present) and unfenced plots (rodents + wild boar present) and a nursery experiment to check seedling emergence and growth. Acorn predation by rodents was almost nil when protected by the device (1.1 vs. 53.4

% without seed shelter), whereas predation by wild boar in the unfenced plots was not reduced by the device (12.4 %) (Castro et al., 2002). In the nursery experiment, there was no effect of the device on seedling emergence or growth. These results suggest that physical protectors like the one used in this study could represent a cheap method to foster the restoration of tree cover via seed sowing, especially if used in combination with fences or habitat features to reduce predation by large animals (Castro et al., 2015).

Oak seedlings grow and branch slowly towards the height in the first year (Fig. 1C). Their main root system develops rapidly during this period. Horizontal lateral roots are developed instead of the main root system in oaks in the rocky foothills. The oaks begin to grow rapidly in length after roots are formed (Steven and Vladan, 2017). Success in afforestation depends on post-planting care and protection (Steven and Vladan, 2017; Jie and Dilnur, 2021; General Directorate of Forestry Strategic Plan 2017-2021, 2016). Reforestation often suffers heavy plant losses due to summer drought. Several techniques are used to alleviate this problem, such as the construction of a water-catchment basin around each plant, planting seedlings having rootballs, applying water-retention gels in the root zone, mycorrhizal inoculation, and providing individual tree shelters (Mesón & Montoya 1993; García-Salmerón 1995; Castro et al., 2002).



Fig. 1. Planting new oak forests. A - Oak acorns suitable for planting; B - Storage of oak acorns for spring planting; C - Annual oak seedling; D - Oak forest

The technology, timing, and amount of care provided for plantations vary because each region has its own climate, vegetation, and soil conditions. Necessary technical measures should be taken to reduce competition with weeds. Afforest areas formed with great effort, money and time, must be protected from humans, animals, insects, and fungal pests. Fencing has a strong positive effect on growth in length, especially for planted seedlings that are taller than the other seedlings and more frequently browsed in non-fenced plots (Birkedal et al., 2009; Magnus et al., 2021). Every precaution must be taken in fire-sensitive areas, especially, a group of workers must be ready to put out the fire at any time. The planting area must be constantly monitored against insect and fungal damage and if yellowing, drying of shoots, or leaves are observed, immediate action must be taken.

The benefits which can provide with reconstructıon of oak forests to our ecology and economıc development in future. Oak is a plant with special ecological, economic and cultural value (Jie and Dilnur, 2021). The establishment of new oak strips in Karabakh is of special importance for the formation and protection of biodiversity. The planting strategy should pay close attention to local land-use issues, to intra- and interspecific genetic diversity, and should adopt relevant, pluri-annual funding schemes and planting contracts rather than letting market opportunities govern the future of forest tree plantations (Fady et al., 2021). Society demands that forests provide a wide range of ecosystem services, from timber products, raw materials, and renewable energy to sociocultural amenities and habitats for nature conservation (Jie and Dilnur, 2021).

The leaves of the plant prevent global warming by eliminating the greenhouse effect by absorbing solar energy and carbon dioxide, and forests are the only hope for solving this global environmental problem. Forests regulate the gas balance and purify the air by absorbing carbon dioxide and other air pollutants through a large adsorbent field (an oak tree absorbs 4.5 kg of carbon dioxide per year), as well as releasing large amounts of oxygen and bactericidal substances into the atmosphere (ucanr.edu). The highly developed root system of oaks prevents landslides by creating a strong network in the soil and reducing the corrosive energy of raindrops during downpours due to the large umbrella, regulating the water balance of soils and rivers. Oak forests create complex ecosystems, which are indispensable for the preservation of ecological diversity and the food chain. The above reflects the ecological value of the oak plant. The forests formed by the ethnobotanical oak plant can be a rich raw material base at a time when the development of the pharmaceutical industry is planned. Forests to be planted with precious woody oak trees can contribute to the Azerbaijani economy after a few decades by leading to the development of industries such as shipbuilding, furniture, coal, wine production. High-quality meat, milk, and eggs can be obtained by using oak acorns, which are rich in organic matter**,** in livestock and poultry (Akkemik, 2020). Oak trees are widely used in the landscaping of parks and alleys in foreign countries, as they form a wide, dense and beautiful decorative umbrella, and the use of oak species in the landscaping may be successful by taking advantage of this experience (ucanr.edu).

In addition to the species that existed in the flora of Karabakh, the transfer of Holm Oak (*Q. Ilex* L.) to natural flora in Azerbaijan, including Karabakh is desirable due to its tolerance to frost, heat, and drought, and fewer requirements for the soil (Gunal, 2011; Akkemik et al., 2020). Holm oak acorns are used as fodder for livestock in Spain, therefore, they are cultivated as fruit trees and cover an area of 4 million hectares. The most expensive truffle fungus forms ectomycorrhiza with holm oak roots (Fischer and Colinas, 1996). In addition, the wood of holm oak is very valuable and has been used since ancient times in shipbuilding, constructions, wagons, wine barrels, etc. (Schirone et al., 2019).

Recent studies have shown that oak species distributed in other regions of Azerbaijan have a high morphological and genetic polymorphism (Aliyeva et al., 2020a, 2020b; Aliyeva 2021; Aliyeva et al., 2021a, 2021b). Genetic diversity is a key component of resilience and adaptability (Fady et al., 2016). This suggests that the studied oak species have a high potential for the formation of new species and adaptability. These results are a promising indicator of the success of the restoration of oak biodiversity in Karabakh. Special projects for the restoration of oak biodiversity in Karabakh should be prepared and implemented in a planned

manner. We, scientists and young researchers are ready to do our best to support our state in the reconstruction of Karabakh (Fig. 1, D) and its transformation into "Paradise Karabakh".

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Qarabağda mövcud olmuş palıd meşlərinin yüksək genetik resurslarının araşdırılması və palıdlıqların bərpasının ekologiya və iqtisadiyyatımıza verəcəyi töhvələrin vurğulanması

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Palıdlar təbii və mədəni irsimizin vacib bir hissəsidir. Qarabağın zəngin florasında biomüxtəlifliyin formalaşmasında palıd ağaclarının özünəməxsus yeri vardı. Belə ki, palıd meşələrinin 35%-dən çoxu Kiçik Qafqazda yayılmışdı, Kiçik Qafqazın ekosisteminin 60%-i məhz palıdlıqların payına düşürdü. Təbii ki, bu göstəricilər I Qarabağ müharibəsindən əvvəlki ədəbiyyat materiallarına əsaslanır. Hazırda bu faiz nisbəti dəyişmiş, Qarabağın- Kiçik Qafqazın biomüxtəlifliyi ciddi təhlükə altındadır. Səbəb dünya ictimaiyyətinə məlum olan erməni vandalizmidir. Məqalədə işğaldan öncəki dövrdə Qarabağda palıdların biomüxtəlifliyi araşdırılmış, həmin ərazilərdə mövcud olmuş palıdlıqların bərpası üçün növlərin ekoloji xüsusiyyətləri qeyd edilmiş və salınacaq yeni palıd meşələrin Azərbaycan təbiətinə və iqtisadiyyatına verəcəyi faydalar diqqətə çatdırılmışdır.

***Açar sözlər**: Qarabağ, palıd, meşəsalma, iqtisadi və ekoloji töhvə*

Исследование генетических ресурсов ныне существующих в Карабахе дубовых лесов и о значении восстановления дубрав для развития нашей экологии и экономики.

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Дубы являются важной частью нашего природного и культурного наследия. В богатой флоре Карабаха дубы занимали особое место в формировании биоразнообразия. Так, 35% дубовых лесов было распространено на Малом Кавказе, причем 60% экосистемы Малого Кавказа приходится на долю дубов. Конечно, эти цифры основаны на докарабахской литературе. В настоящее время этот процент изменился, и биоразнообразие Карабаха и Малого Кавказа находится под серьезной угрозой. Причина - известный мировой общественности армянский вандализм. В статье исследуется биоразнообразие карабахских дубов в дооккупационный период, отмечаются экологические характеристики различных видов для восстановления некогда распространенных на этих территориях дубов, а также подчеркиваются преимущества новых дубовых лесов для природы и экономики Азербайджана в ближайшем будущем.

Ключевые слова: *Карабах, дуб, лесоразведение, экономическая и экологическая выгода*

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Special protected natural areas of Karabakh released from occupation

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The organization of specially protected natural areas is considered to be the most optimal choice for the protection of the whole natural landscape and its dynamic components like vegetation and wildlife. Although, the strict regime was established by our state in specially protected natural areas of Azerbaijan, as a result of Armenia's near-30-year military aggression, rare and unique natural monuments of a number of reserves and sanctuaries were looted in Karabakh. At present, the main purpose of monitoring in these areas is to calculate the damage and develop practical measures for the restoration of the area.

***Keywords:** Caucasus, Azerbaijan, Karabakh, flora, forests*

The organization of specially protected natural areas is considered to be the most optimal choice for the protection of the whole natural landscape and its dynamic components like vegetation and wildlife. Although inspite of the strict regime established by our state in specially protected natural areas of Azerbaijan, as a result of Armenia's near-30-year military aggression against Azerbaijan, have been looted rare and unique natural monuments of a number of reserves and sanctuaries in Karabakh. At present, the main purpose of monitoring in these areas is to calculate the damage and develop practical measures for the restoration of the area.

Karabakh is one of the richest phytogeographical regions not only of the Republic of Azerbaijan, but also of the Caucasus as a whole. This region along with other natural resources, It is also distinguished by the richness of flora and vegetation (Fig. 1). This richness is primarily due to the extremely complex natural conditions, geological and geomorphological structure of the area. Among the valuable plant species found here are many medicinal, food, vitamin, dye, fodder and other useful plants (Fig. 2). According to pre-occupation research, more than 2,000 higher plant species are found in the territory of Karabakh, which is more than 42% of the higher plant species of the Azerbaijani flora (Asgarov, 2016).

The natural vegetation of the currently released from occupatıon regions of Karabakh is protected in the following reserves and sanctuaries:

Basitchay State Nature Reserve is located in the Basitchay valley in Zangilan district. Reserve area is 107-hectare. The oriental plane tree forest covered 100 hectares of the whole area. Plane trees as a valuable relict plant species was included to the "Red Book" of Azerbaijan. The climatic conditions of the area are very favorable for the natural regeneration and development of plane trees. The length of the reserve is along the valley is -15 km, and its width in some places reaches 150-200 m. Up to 80% of the area was covered with forest, 14% was sparsely forested. There also were distributed walnuts, hackberries, mulberries, willows, poplars, hawthorns, hips, European buckthorn, thorn and other trees and shrubs in the area. During the occupation, this unique reserve area was destroyed, valuable plane trees were cut down for various purposes and transported to wood processing workshops or uprooted and relocated to different parts of Armenia (Sokolov and Syroechkovsky, 1990).

Garagol State Nature Reserve was of special importance in the protection of typical alpine meadows of the highlands in Lachin region (Fig. 3). The total area of the reserve was 240 hectares. More than 100 valuable plant species were preserved here. During the occupation, lake's water

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were intensively used for watering established various purpose farms in the surrounding areas of the lake. All these led to water pollution and lowering of its level of the lake.

Lachin District State Nature Reserve was established in Lachin District and covers an area of 20,000 hectares (Fig. 4). The highest peak of the reserve is Kirghiz Mountain (2825 m), which has a medium and high mountainous relief and includes Shalva, Pichenis, Gorchu and others rivers. Relief of the reserve sharply divided by deep ravines where rivers flow. Vegetation cover of the area is consisting of medium mountain Iberian oak forest (1000-1700 m), upper mountain eastern oak forest (1700-2200 m), subalpine (2200-2500 m) and alpine (2500-2800 m) meadows. The reserve area is mainly inhabited by hornbeam, linden, maple, etc. mixed forests. İn the reserve in Hajishamli forest, was protected Sessile oak which a valuable plant species covering more than 4,000 hectares. During the occupation, this valuable plant was ruthlessly destroyed and plundered for the production of wine barrels.

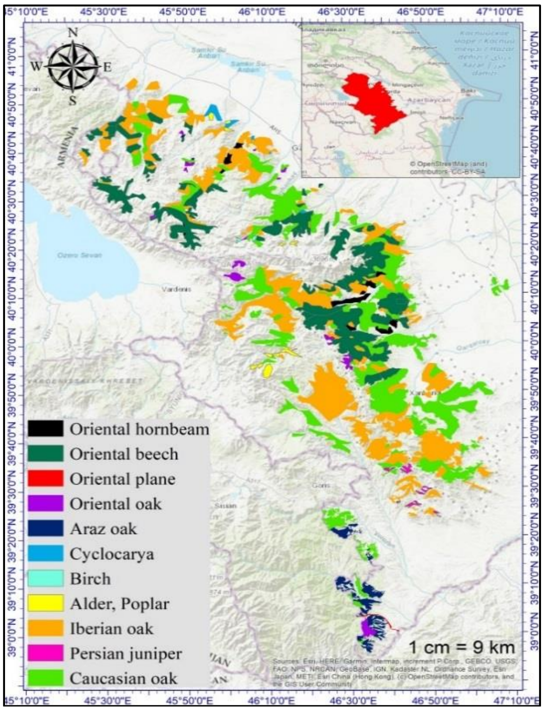


Fig. 1. Main tree species of forests

Gubadli State Nature Reserve is located on 20,000 hectares area in the northern part of Gubadli and the southern part of Lachin region. The 8,500-hectare forest of the reserve consists mainly of oak and hornbeam trees. Reserve was created to protect and enhance wild animals likeroe deer, wild boar, bear, wolf, pheasant, partridge, quail, pigeon, etc. There were widespread oak, walnut, hornbeam, maple, juniper, hawthorn, hips, blackberries, etc. trees and shrubs. These valuable natural areas have been looted and severely damaged.

Dashalti State Nature Reserve which covering 450 hectares area was established in Shusha and Khojaly in order to protect and preserve rare natural complexes, especially historical and paleontological monuments, as a reference area. Besides Shusha hornbeam, caucasian hackberry, english yew, orchis there were speared out rare plants such as maple, linden, ash, hawthorn, hips, cornel, medlar, apple, pear etc.

Table 1. Specially protected forests (forests with the status of natural monuments).

№	Name of the administrative district	Name of forestry	Area of site (ha)
1.	Ağdam	Pistachio forest	732
2.	Kalbajar	Storax forest	968
3.	Lachin	Juniper forest	1092
4.	Khojavend	Zelkova tree forest	0,5
5.	Zangilan	Araz oak forest	10,000
6.	Aghdara	Oriental plane tree forest	5
7.	Khankendi	Oak forest	20

The Arazboyu State Nature Reserve was established on the border of the Zangilan region with Iran, on the banks of the Araz River. The reserve covers 2,200 hectares area. Willow, poplar, athel, gum, plane tree, elm, silverberry and liquorice are widespread here. The main purpose of the reserve was to protect tugai forests.

Among the specially protected areas, forests with the status of natural monuments were of special importance in the protection of a number of rare and valuable plant species (Table 1).

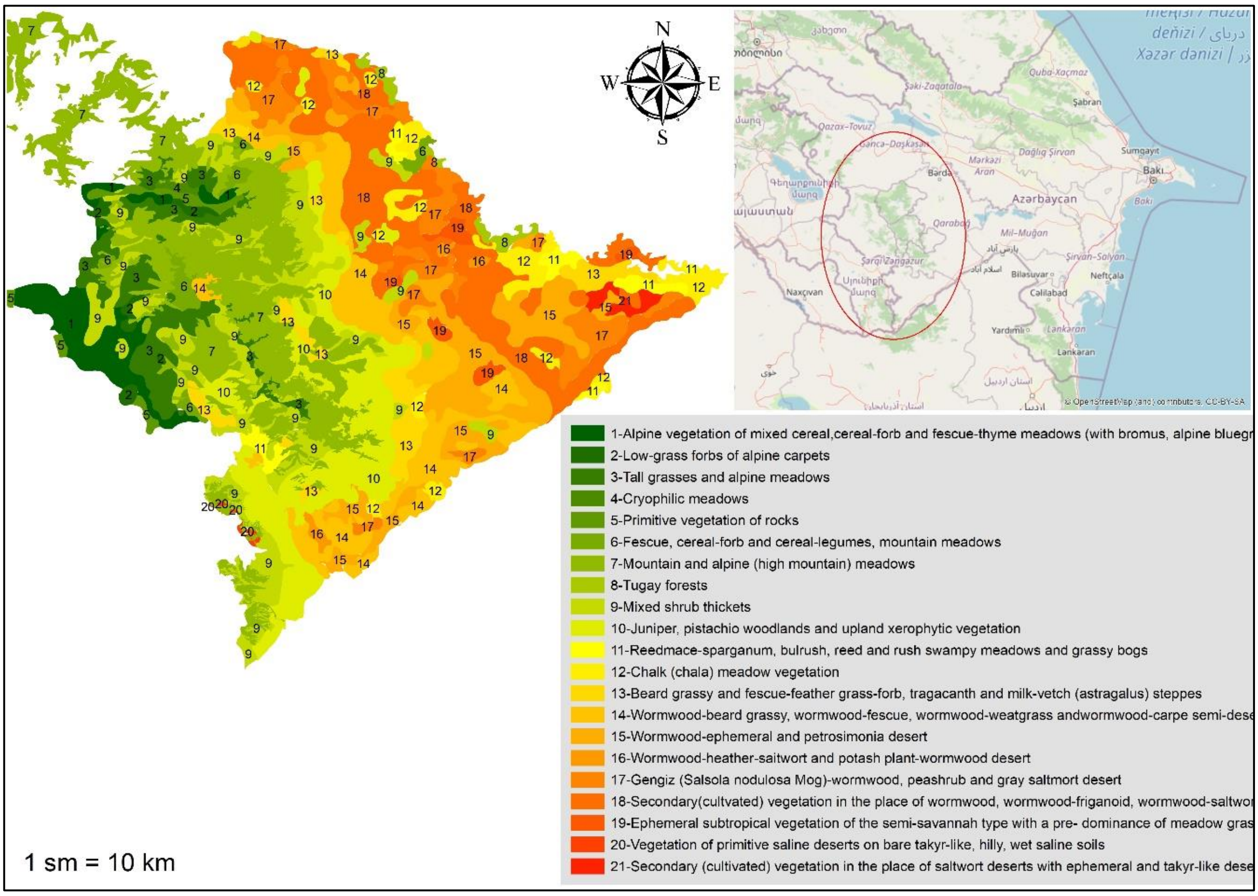


Fig. 2. Vegetation of the Karabakh region



Fig. 3. Karagol State Nature Reserve



Fig. 4. Lachin region State Nature Reserve

In order to sustainably develop and manage the vegetation of specially protected areas, it is expedient to conduct inventory work, monitoring and research based on modern methods, calculate the damage and implement measures to restore the ecosystem. Expansion of the territory of Basitchay State Nature Reserve at the expense of Arazboyu State Nature Reserve located in Zangilan region, creation of Khudafer National Park on their basis, as well as inventory of natural monuments in the liberated areas are among the urgent issues.

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İşğaldan azad olunmuş Qarabağın xüsusi mühafizə olunan əraziləri

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Qarabağ nəinki Azərbaycanın, hətta bütövlükdə Qafqazın ən zəngin fitocoğrafi regionlarından biri olmaqla, digər təbii sərvətləri ilə yanaşı, flora və bitki örtüyü zənginliyi ilə də seçilir. Məqalənin məqsədi Ermənistanın 30 ilə yaxın bir dövrdə Azərbaycana qarşı davam etmiş hərbi təcavüzü nəticəsində Qarabağda olan bir sıra qoruq və yasaqlıqların nadir və unikal təbiət abidələrinin mövcud vəziyyətinin dəyərləndirilməsidir.Hazırda həmin regionda 2 dövlət qoruğu, 4 dövlət yasaqlığı mövcuddur. Zəngilan rayonunda yerləşən Arazboyu Dövlət Təbiət Yasaqlığının ərazisi hesabına Bəsitçay Dövlət Təbiət Qoruğunun ərazisinin genişləndirilməsi, onların bazasında Xudafərin Milli Parkının yaradılması zəruri olan məsələlərdəndir.

Açar sözlər: *Qafqaz, Azərbaycan, Qarabağ, flora, meşələr*

Освобожденные от оккупации особо охраняемые территории Карабаха

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Карабах - один из богатейших фитогеографических регионов не только Азербайджана, но и Кавказа в целом. Наряду с другими природными ресурсами, Карабах отличается богатой флорой и растительностью. Целью данной статьи является оценка современного состояния редких и уникальных памятников природы в ряде заповедников и заказников Карабаха, после почти 30-летней военной агрессии Армении против Азербайджана. В настоящее время в регионе действуют 2 государственных заповедника и 4 государственных заказника. Расширение территории Баситчайского государственного природного заповедника за счет территории Аразбоюского государственного природного заказника, расположенного в Зангиланском районе, создание на их базе Худаферинского национального парка является одной из важных и актуальных задач.

Ключевые слова: *Кавказ, Азербайджан, Карабах, флора, леса*

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Prospects of biodiversity research in water basins of the Karabakh region

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The article is devoted to the prospects of scientific research of biodiversity in the water basins of the Karabakh territory liberated from the 30-year Armenian occupation. Both flora and fauna barbarously looted and destroyed by the invaders are subjects to comprehensive restoration, and the elaboration of scientifically based approaches to the development of the once-prosperous region remains with the scientists of the Republic. The primary tasks facing scientists are the analysis of the state of biodiversity of the water basins located in the territories of Karabakh, in particular, the establishment of species and stocks of fish belonging to the local ichthyofauna, the study of the potential of the food base. The article gives the names of rivers and other water sources of the Karabakh zone, where natural fish farming and aquaculture can be developed. A list of multidisciplinary studies necessary for the restoration and development of aquatic biodiversity in the liberated territories of Karabakh is proposed. The article is preceded by a brief review of works on the research of the physiology and ecology of fish in the reservoirs of the Republic, focusing on sturgeon, which is of industrial importance for the country.

Keywords: *Karabakh, biodiversity, water basins, sturgeon, fisheries*

INTRODUCTION

The Karabakh land remained under occupation for nearly 30 years, and its rich biodiversity was not only left out of scientific research but also subjected to ecological terror and was brutally exploited by Armenian invaders. It should be noted that before the occupation, the scientists of the Institute of Zoology of the Azerbaijan Academy of Sciences conducted some researches in the reservoirs located in Karabakh (Державин, 1956; Əbdürrəhmanov, 1966; Насиров, Мамедова, 1975) but these researches were not long-term.

The study of sturgeon fish species occupies an important place in ecological, physiological studies of fish in the water reservoirs of the Republic. Numerous studies have been devoted to the study of the ecological and physiological features of the oldest, but at the same time of high industrial importance, sturgeon fish species, their reproduction in factory conditions and the determination of the optimal environment for proper cultivation (Касимов, 1961; Касимов и др., 1966). The results of these studies have played an important role in the conservation and reproduction of fish stocks, the oldest representative of the aquatic biodiversity of the Republic.

In studies conducted using the classical method of forming conditioned reflexes, a biologically expedient method and the selection of conditioned stimuli, it was proved that both food and protective conditioned reflexes in sturgeons can be created very quickly, and their nervous processes do not lag behind other, more highly organized animals in their mobility and expediency (Касимов, Рустамова, 1969; Палатников, Касимов, 1980). At the same time, it was revealed that the analytical and synthetic activity of the nervous system in evolutionarily ancient sturgeon fish is below the level. The results obtained were taken as a basis for the organization of industrial breeding of sturgeon in the former USSR, which became the basis for the creation of the theory of biological progress of sturgeon.

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A consistent study of genetically determined behavioral reactions at the early stages of ontogenesis and their ecological plasticity at the species and population levels allowed us to identify adaptive reactions to individual environmental factors

In a number of works, the morphofunctional organization of the taste and visual systems of sturgeon fish was also studied (Крацкин и др, 1977; Палатников, Касимов, 1980). The research was of great importance not only for fundamental science, but it also served to develop specific guidelines for creating optimal conditions for the artificial cultivation of these valuable fish species, thereby reducing the death of fry in the early stages of ontogenesis during their breeding and cultivation in factory conditions (Gasimov et al., 2017)

There has been great importance the studies on the ecological and physiological features of the development in the ontogenesis of valuable fish species of the Kura River region (sturgeons, zanders, carps) (Касимов и др, 1966). Using ethological, morphological, physiological, and ecological research methods, the most optimal conditions for obtaining and fertilizing caviar in individual fish species, temperature, salinity, light and oxygen conditions for the development of fry and fish at various stages of growth have been identified. The results of these studies have played a special role in improving existing and creating new biotechnical standards for the cultivation and breeding of various fish species in Azerbaijan and have found wide application in farms.

The results of the above-mentioned studies are summarized in a number of monographs, served as the basis for the development of recommendations for the factory cultivation of certain species of sturgeon, optimization of the timing and conditions for the release of fry into natural reservoirs (Касимов, 1980, 1987; Лукьяненко и др., 1984). These results have also been confirmed in joint studies with French scientists on the localization and staging of functions in the development of the brain of sturgeon (Веселкин и др., 1977).

As a result of many years of research, Azerbaijani scientists have obtained and grown interspecies reciprocal hybrids of sturgeon for the first time. In the first three years of life of these fishes, ecological plasticity and adaptive capabilities were revealed, the hereditary transmission of morphophysiological characteristics in direct and reciprocal hybrids was studied. Based on the results of joint research by scientists of the Azerbaijan branch of the Central Research Institute of Sturgeon Farming and the I.Pavlov Institute of Physiology, hybrid of sturgeon fishes (*Acipenser nudiventris and Huso huso*) was proposed for breeding in aquaculture farms of the USSR, which was distinguished by high adaptive capabilities in terms of freshwater tolerance, growth, and other physiological characteristics (Касимов, 1970).

Another priority of research in the field of physiology and ecology of fish in the country was to study the effect of oil and other chemical pollutants on the physiological functions of aquatic organisms (Касимов, Рустамова, 1969; Gaisina, Kasimov, 2019). Scientists of the Laboratory of ecological physiology (Head Prof. Rafik Kasimov) in Institute of Physiology of the Academy of Sciences of Azerbaijan in cooperation with the Scientific Research Institute of Oil and Gas and the Institute of Fisheries "Azerbalig" in these applied studies, which are important for the ecology of the Caspian Sea, studied the effect of crude oil, drilling mud, sludge and other chemical reagents on sturgeon fry and determined their permissible concentrations for the Caspian environment. It has been proposed effective methods for neutralizing particularly harmful components. The results of ecotoxicological studies have been presented at numerous symposiums and conferences, repeatedly demonstrated at the All-Union Exhibition of Achievements of the National Economy (Moscow), awarded the gold medal of the Leipzig Fair.

All these achievements of the Azerbaijani school of physiology and ecology of fish will be demanded during the restoration of the aquatic biodiversity of the Karabakh territory, the development of natural fish farming, as well as the introduction of aquaculture methods for growing valuable fish species, including sturgeon (Мамедов и др., 2013; Freyhof et al., 2020).

There are 14 rivers and more than 10 other water sources in the liberated Karabakh zone.

The sources of water available in the Karabakh region start from the Lesser Caucasus mountains. The main sources of water reserves in this region are as follows: the rivers Tartarchay (*Tərtərçay*), Hakari (*Həkəri*), Khachinchay (*Xaçın-*

çay), Gargarchay (*Qarqarçay*), Bazarchay (*Bazarçay*), Okhchuchay (*Oxçuçay*) and the water reservoirs Khudaferin (*Xudafərin*), Giz Galasi (*Maiden Tower – Qız Qalası*) (located on the Araz River) and Sarsang (*Sərsəng*) reservoirs (located on Tartar river). Besides, many small rivers, lakes, and several reservoirs are planned to build. Today, in the context of the state-level restoration work on the liberated Karabakh territories, our scientists have great responsibilities.

Analysis of biodiversity, especially fish species in water basins located in Karabakh, determination of the level of their resources, the study of feed base are among the main tasks facing scientists. Extensive multidisciplinary research on the restoration, storage, and efficient use of fish resources is required.

It should be noted that the information on studying the biodiversity of the water basins of Karabakh in the pre-occupation period was of a general nature and mainly dominated by its fundamental importance. From an economic point of view, inland water basins were not given much importance due to the fact that the fishery in the Caspian Sea and other water basins (Kura river, Mingachevir reservoir) met the country's demand. The lack of relations of water basins in the liberated territories of Karabakh (except for Araz river and Okhchuchay) with the territories of the neighboring states creates good conditions for their ecologically clean water and development of Fisheries. Therefore, conducting complex research in the Karabakh water basins in the post-conflict period is of great importance both in terms of biodiversity protection and in terms of economy.

First of all, passportization of water basins should be carried out from the liberated zones of Karabakh.

At later stages, the following studies should be conducted sequentially:

- Passportization must be carried out in accordance with international rules in rivers and water reservoirs (location, sources of water, etc. must be specified);
- Monitoring of rivers and water basins (chemical composition of water and bottom sediments, water volume depending on the seasons, average temperature limit, etc. must be studied);
- The study of biodiversity should be organized. For this purpose, species composition and stocks of aquatic organisms (algae, infusorias, fishes, etc.) should be determined.
- It is necessary to study the distribution of industrially important fish, their stocks, and ways to restore;
- Work should begin to explore the possibilities of aquaculture of industrially important fish in water reservoirs;
- Studies should be carried out on the transfer and adaptation of new species of fish in rivers and other water basins.

In order to carry out all these studies, permanent control points should be established.

The creation of several fish farms on the Terter River (from Kalbajar to Sugovushan) for the cultivation of commercial trout in the conditions of aquaculture can provide a certain share of demand for these products in our country. During the implementation of these works, the physiological state of fish living in the waters of the areas liberated from occupation should be studied and an appropriate ecotoxicological and parasitological study conducted.

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Qarabağ regionunun su hövzələrində biomüxtəlifliyin tədqiqinin perspektivləri

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Məqalə 30 illik erməni işğalından azad edilmiş Qarabağ ərazisinin su hövzələrində biomüxtəlifliyin elmi tədqiqatlarının perspektivlərinə həsr edilmişdir. İşğalçılar tərəfindən talan edilmiş flora və fauna hərtərəfli bərpa olunmalıdır və bir zamanlar çiçəklənən diyarın inkişafına elmi cəhətdən əsaslandırılmış yanaşmaların işlənib hazırlanması respublika alimlərinin arxasında qalır. Qarabağ ərazisində yerləşən su hövzələrinin biomüxtəlifliyinin vəziyyətinin təhlili, xüsusilə yerli ixtiofauna aid balıq növlərinin və ehtiyatlarının müəyyən edilməsi, yem bazasının potensialının öyrənilməsi alimlərin qarşısında duran birinci dərəcəli vəzifələrdir. Məqalədə Qarabağ zonasının çaylarının və digər su mənbələrinin adları göstərilir. Qarabağ ərazisində su biomüxtəlifliyinin bərpası və inkişafı üçün zəruri olan multidisiplinar tədqiqatların siyahısı təklif olunur. Məqalənin girişində Respublikanın su hövzələrində balıqların fiziologiyası və ekologiyası üzrə aparılan tədqiqatların qısa xülasəsəi verilib və əsas aksent ölkə üçün mühüm sənaye əhəmiyyəti olan nərəkimilərə yönəlmişdir.

Açar sözlər: *Qarabağ, biomüxtəliflik, su hövzələri, nərəkimilər, balıqçılıq*

Перспективные исследования биоразнообразия в водных бассейнах Карабахского региона

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Статья посвящена перспективам научных исследований биоразнообразия в водных бассейнах Карабахской территории, освобожденной от 30-летней армянской оккупации. Варварски разграбленные, уничтоженные оккупантами флора и фауна, подлежат всестороннему восстановлению, и разработка научно обоснованных подходов к развитию некогда процветающего края остается за учеными Республики. Первостепенными задачами, стоящими перед учеными, являются анализ состояния биоразнообразия водных бассейнов, находящихся на территориях Карабаха, в особенности, установление видов и запасов рыб, относящихся к местной ихтиофауне, изучение потенциала кормовой базы. В статье приводятся названия рек и других водных источников Карабахской зоны, где могут быть развиты натуральное рыбоводство и аквакультура. Предлагается перечень мультидисциплинарных исследований, необходимых для восстановления и развития водного биоразнообразия на освобожденных территориях Карабаха. Статью предваряет краткий обзор работ по исследованиям физиологии и экологии рыб в водоемах Республики, акцентируя основное внимание на осетровых, имеющих промышленное значение для страны.

Ключевые слова: *Карабах, биоразнообразие, водные бассейны, осетровые, рыбоводство*

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Comparative analysis of agrobiological traits of durum (*T. durum* Desf.) and bread wheat (*T. aestivum* L.) varieties in the Karabakh region

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Agrobiological features of new perspective durum wheat varieties "Maya", "Alliance" and bread wheat varieties "Leyla", "Start", "Janub", "Khamsa", "Almaz", "Oguz", "Vilash" created as a result of many years of research (2005-2020) of the Genetic Resources Institute (GRI) of ANAS and the Scientific Research Institute of Crop Husbandry (RICH) in the Karabakh region were compared. The varieties were characterized by high adaptability and potential productivity. Among them "Start" (patent № 00246), "Janub" (patent № 00274), "Leyla" (patent № 00305) and "Almaz" (patent № 00312) varieties of bread wheat, "Maya" (patent № 00250) and "Alliance" (patent № 00316) varieties of durum wheat were patented by the Agrarian Services Agency and regionalized. The studied varieties were analyzed for height, productivity and structural elements, resistance to rust diseases and adaptability in the competitive variety testing nursery. In the year of epiphytosis (2020), durum wheat varieties and "Almaz" and "Khamsa" bread wheat varieties were resistant to yellow rust. Significant differences were also observed in terms of productivity and structural elements. In addition, the new durum and bread wheat varieties were characterized by morphobiological and agronomic features and characteristics. Optimal cultivation technology of regionalized varieties, predecessors, fertilizer norms and sowing period were also given. It is recommended to cultivate new varieties in the irrigated plains and moisture-supplied foothills of the Karabakh region.

Keywords: *Durum wheat, bread wheat, yellow rust, brown rust, variety, productivity, resistance*

INTRODUCTION

To ensure the efficient use of arable land in the liberated areas, it is extremely important to create productive and resistant plant varieties to unfavorable environmental factors and to organize the seed production of varieties created in previous years. After the Second Karabakh War, one of the main tasks of biological and agrarian sciences was to create new, high-yielding intensive varieties suitable for local conditions and ensure their distribution among farmers through the efficient use of existing genetic resources.

Bread wheat (*T. aestivum* L.) and durum wheat (*T. durum* Desf.) are of special strategic importance in ensuring the economic security of the country. Since ancient times, durum wheat varieties have been cultivated in the plains and foothills of Azerbaijan, and bread wheat in mountainous areas, mainly in winter sowings (Mustafayev, 1973; Aliyev, 2006; Rustamov et al., 2020).

The main fund, production and other buildings of the Karabakh Scientific Research Base (SRB) of the Genetic Resources Institute were completely destroyed as a result of the Armenian aggression. Karabakh SRB, located in the former Aghdara region (Shikharkh settlement of Tartar region), functioned from 1950 to July 1989 as a world-renowned exemplary research base. The main activities of the base were the collection, study, efficient use of genetic resources of cereals, legumes, fodder, technical, fruit, berries, grapes,

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etc. plants, as well as agricultural animals in breeding, creation of new plant varieties and animal breeds, organization and dissemination of their initial breeding.

The territory of the liberated Karabakh region is divided into plains, foothills and mountainous parts, and the soil and climatic conditions are different. Therefore, it is very important to create varieties suitable for a wide range of soil and climatic conditions of the region (temperature, humidity, precipitation evaporation ratio, soil type, amount of humus, etc.), to select and distribute varieties that successfully pass production tests.

Taking into account the need of Azerbaijan for wheat and the urgency of restoring wheat fields in the liberated territories, new bread and durum wheat varieties with high adaptability to the soil and climatic conditions of the Karabakh and East Zangazur economic regions were created by scientists of the Genetic Resources Institute during 2005-2020. Their valuable economic indicators were compared and the initial seed production of selected varieties was organized. The initiated research and activities will be continued in the coming years at a faster pace and using all the opportunities of modern breeding.

MATERIALS AND METHODS

The researches were carried out in 2005-2020 in Buruj village, Tartar region, near the Karabakh Scientific Research Base of GEI, on a farm, under irrigation conditions. The experimental area is located in the northeastern foothills of the Lesser Caucasus - in the irrigated Karabakh plain, at an altitude of 190.0 m above sea level. The climate of the region is moderately warm, winters are mild and summers are dry and hot. In recent years, the climatic indicators of the region have differed sharply (Rustamov, 2019; Rustamov et al., 2020). Different generations of hybrid materials, regionalized and promising durum and bread wheat varieties were taken as research material. Experiments, phenological observations, assessment of productivity and structural elements, disease resistance were carried out following the relevant methodologies (Musayev et al., 2008; Duveiller et al., 2014). In hybrid and breeding nurseries, sowing was carried out by hand, and in control and competitive variety nurseries, sowing was carried out with a grain spreader in 2-4 repetitions with a sowing area of 50 m^2. The experiments were carried out in accordance with the stages of plant development; irrigation and feeding with mineral fertilizers in spring were fulfilled. All nurseries were assessed for leaf disease and pest infestation at the beginning of wax ripeness.

RESULTS AND DISCUSSION

The most effective way to increase grain production and meet the population's demand for food products through domestic production is to increase the complex resistance to biotic (disease, pests, plant density, etc.) and abiotic (salt, drought, frost, cold, etc.) factors, high productivity and creation of high-quality varieties, optimization of their elite and reproductive seed production. For this purpose, in recent decades the gene pool of durum and bread wheat has been enriched at the Genetic Resources Institute of ANAS through hybridization, expeditions and exchange. The genetic diversity of wheat in different soil-climatic conditions was evaluated for resistance to biotic and abiotic factors, productivity and grain quality in laboratory and field conditions, and initial breeding materials were created by conducting selection work.

As a result of the research, in recent years at the Genetic Resources Institute of ANAS new bread wheat varieties "Leyla", "Start", "Janub", "Khamsa", "Almaz", "Oguz", "Vilash" and durum wheat varieties "Maya" and "Alliance" which are distinguished by high potential, adaptive productivity and quality of grain were created. Among them “Start” (Certificate of Authorship № 00246), “Janub” (№ 00274), “Leyla” (№ 00305) and “Almaz” (№ 00312) varieties of bread wheat, “Maya” (№ 00250) and “Alliance” (№ 00316) varieties of durum wheat was regionalized by the Agrarian Services Agency with a patent certificate.

The studied regionalized and perspective varieties were evaluated for diseases resistance, dormancy, their productivity was determined and structural analyzes were carried out in the competitive variety testing (CVT) nursery (Table 1).

Table 1. Agrobiological indicators of the varieties studied in the competitive variety testing nursery (Karabakh SRB Tartar, 2020).

S/s, 2020	Catalog	Plant height, cm	Productive tillering	Spike			Productivity, c/ha	Standard deviation, ±c/ha
				length, cm	Number of seeds	Seed weight, g.		
1	Aran (St.)	112.7	6.1	10.2	49.5	2.01	64.0	0.0
2	Almaz	107.3	6.1	11.1	57.1	2.9	66.0	+2.0
3	Start	110.1	5.7	13.7	58.8	2.7	70.0	+6.0
5	Janub	108.7	6.0	9.3	61.7	2.8	70.0	+6.0
6	Leyla	94.4	5.6	10.5	55.7	2.45	54.0	-10.0
7	Khamsa	90.9	6.3	13.3	69.8	3.21	70.0	+6.0
8	v. *ferrugineum*	107.0	6.6	9.1	56.9	2.8	66.0	+2.0
9	TT 09214/3-7-2-1	114.0	6.0	11.2	62.1	3.04	68.0	+4.0
10	TT 09214/3-7-2-1 0815/2-2	116.3	5.0	11.6	61.7	2.9	74.0	+10.0
11	v. *lutescens x* v. *graecum*	83.8	6.0	9.8	55.0	2.0	56.0	-8.0
12	v. *lutescens x* v. *graecum*	82.6	5.9	10.2	61.1	2.3	64.0	0.0
13	Barakatli 95 (St.)	104.7	7.1	9.7	70.0	3.9	54.0	0.0
14	Maya	98.5	7.4	10.7	69.8	3.8	74.0	+20.0
15	Allians	104.9	8.4	11.3	78.4	4.9	60.0	+6.0

As can be seen from the table, the height indicators varied between 82.6-116.3 cm, "Khamsa" and fixed hybrid lines differed in short height. Significant differences were also observed in terms of productivity and its structural elements.

Infectious diseases (yellow and brown rust) of the studied varieties were studied in the competitive variety testing nursery. It should be noted that epiphytosis of yellow rust has been observed in the last year, and most of the varieties studied have been infected with this disease at one or another level. Only durum wheat varieties and bread wheat Almaz and Khamsa showed full resistance to yellow rust (Fig. 1).

30.8-69.0% of the studied varieties showed resistance to yellow and brown rust, 46.2-16.0% were fully sensitive (Fig. 1). According to the 3-years average productivity of the varieties studied in the competitive variety testing nursery, it can be said that the studied bread wheat varieties showed 1.2-17.4 c/ha higher results than the standard Aran variety. The productivity of Maya and Alliance durum wheat varieties was 6.3-8.6 c/ha higher than Barakatli 95 (Table 2).

As can be seen from Table 2, the productivity of new regionalized and promising (TT 09704/2-4-1-2, Start, Khamsa and var. *ferrugineum*) bread wheat varieties is much higher than the standard Aran variety.

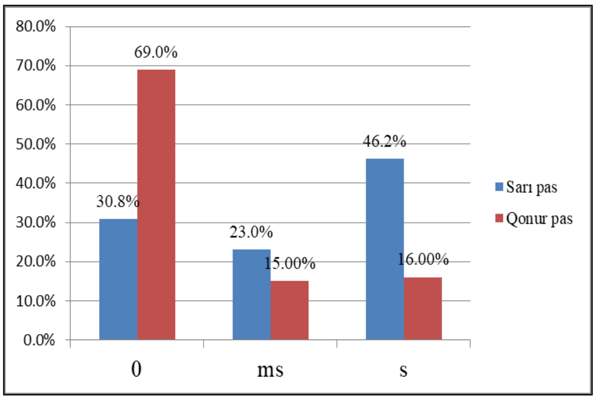


Fig. 1. Yellow and brown rust infection of cultivars studied at the CVT (Tartar, 2021)

The standard deviation indicates that the productivity of Almaz, TT 09704 / 2-4-1-2, Start, and Janub varieties are relatively stable. The average perennial productivity of “Maya” and “Alliance” (69.5±7.37 - 67.2±8.13) durum wheat varieties do not lag behind the new bread wheat varieties, except for Khamsa (74.7±8.2). Productivity stability in new durum wheat varieties is lower than in bread wheat varieties.

Table 2. 3-year productivity indicators of varieties studied in the competitive variety testing nursery in Karabakh SRB, Tartar, 2018-2020.

Variety, accession	Productivity, c/ha				Standard deviation, c/ha
	2018	2019	2020	Average, c/h	
Aran (Standard)	61.5	56.5	64.0	60.7±3.82	0.0
Almaz	68.5	66.5	66.0	67.0±1.0	+6.3
TT 09704/2-4-1-2	68.5	71.0	54.5	68.5±1.80	+7.8
Start	66.5	69.0	70.0	68.5±1.80	+7.8
Janub	64.5	66.0	70.0	66.8±2.84	+6.1
Leyla	62.0	59.5	54.0	58.5±4.09	-2.2
Khamsa	75.5	78.5	70.0	74.7±8.2	+14.0
v. ferrugineum	69.5	75.5	66.0	67.5±4.31	+6.8
Barakatli 95 (Standard)	62.6	66.0	54.0	60.9±6.19	0.0
Maya	61.0	73.5	74.0	69.5±7.37	+8.6
Allians	65.5	76.0	60.0	67.2±8.13	+6.3



Fig. 2. New durum and bread wheat varieties

The morphobiological and agronomic traits and characteristics of regionalized and promising bread and durum wheat varieties are given below:

"Start" bread wheat variety

Authors: Abdullayev A.M., Akparov Z.I., Talai J.M., Abbasov M.A., Shikhlinski H.M.

"Start" bread wheat variety was created by repeated individual selection in Karabakh SRB from a complex hybrid combination (TB 0815/2-2 [(TB Akhatsikhis Tsiteli Doli x 45319 Panonia) x 45319 Panonia] x AB 01090- (Sharbat sonora x Dwarf). The variety presented in the State Variety Testing in 2016, regionalized in 2019. Patent № 00246.

"Start" variety is of medium height (101-124.8 cm), has a high branching coefficient (3.2-3.6 pieces). It is resistant to lodging and medium ripening (224.3 days) in a high agronomic background. The leaves and spikelets are hairless, green, covered with a layer of wax. Spikes are thorn-shaped, white, seeds are dark red, the variety belongs to var. *lutescens*. Spike is long (11.6-12.6 cm) with medium dense (21.0-23.0 pieces). The spikelets are sparsely arranged on the spike axis. The number of grains per spike is 52.0-76.5, and the three-year average is 52.0. The 1000 seed weight is 43.8-45.5 g, the net weight is 792 g. The vitreousness of the grain is high (93.0%). The amount of protein in the grain is 12.2-15.0%, and the amount of gluten is up to 29.6%. The potential productivity of the Start variety is high - 76.5 c/ha. The three-year average yield in the competitive variety testing nursery was 66.2 c/ha, which is 5.2 c/ha more than the standard Aran variety (61.0 c/ha). The variety is medium resistant to yellow and brown rust.

"Janub" bread wheat variety

Authors: Abdullayev A.M., Akparov Z.İ., Talai C.M., Rustamov Kh.N., Abbasov M.A., Shikhlinski H.M., Morgunov A.İ., Sadigov H.B.

The "Janub" variety of bread wheat was created in the Karabakh SRB by repeated individual

selection from a complex hybrid [(Ulugbey x Mexican yarovaya line) x Sanzor 6] selected from international nurseries. It was submitted to the State Variety Testing in 2016 and regionalized in 2020. Patent № 00274.

"Janub" variety is of medium height (92.6-116.5 cm) with high branching. Resistant to lodging, semi-winter with medium maturity (210-218 days). The spike is cylindrical, long (9.4-14.0 cm) with medium density (19.0-23.0 pieces), white, seeds are dark red, belongs to var. *erythrospermum*. The number of grains per spike is 41.2-60.2, the three-year average is 52.2. The 1000 seed weight is 34.6-44.6 g, the net weight is 792 grams. The amount of protein in the grain is 13.6-14.2%, the amount of gluten is up to 34.0%. The potential productivity of the "Janub" variety is high - 67.2 c/ha. The three-year average yield in the competitive variety testing nursery was 63.2 c/ha, 4.0 c/ha more than Aran (59.2 c/ha).

"Leyla" bread wheat variety

Authors: Akparov Z.İ., Abbasov M.A., Sheykhzamanova F.A., Rzayeva S.P., Rustamov Kh.N., Sadigov H.B.

"Leyla" bread wheat variety was created at the Genetic Resources Institute of ANAS in 2009 by repeated individual selection from the genotype obtained from hybridization of bread wheat accessions (var. *ferrugineum* x var. *velutinum*) selected for complex economic valuable features. It was submitted to the State Variety Testing in 2015 and regionalized in 2021. Patent № 00305.

"Leyla" variety is of medium height (110-120 cm), semi-intensive type, with strong stem; highly resistant to lodging. Productive branches are high (5.0 pcs.), lifestyle is semi-winter, belongs to var. *lutescens*. The spike is straight, of medium length (9.5 cm), white-colored. In the spike, the spikelets are located in the middle density (D = 19-21 pieces). It is awnless. The seed is of medium length, large, hairy, and white. The potential productivity of the "Leyla" variety is high - 100-110 c/ha. In the competitive variety testing, the 3-year average yield was 105.3 c/ha, 28.7 c/ha higher than the Aran variety. In ecological tests conducted in Tartar and Gobustan conditions, more than 2.0-3.7 t/ha of products were obtained from regionalized varieties. The number of grains per spike is 62.7, the 1000 seed weight is 53.4 g, the net weight is 810.0 g. The amount of protein in the grain is 13.8%, and gluten content is 26.6-32%. Moderately resistant to rust and powdery mildew.

"Almaz" bread wheat variety

Authors: Abdullayev A.M., Akparov Z.İ., Rustamov Kh.N., Abbasov M.A., Rafiyev E.B., Mehdiyev H.M., Gurbanov F.J.

The "Almaz" variety was created by repeated individual selection from a complex hybrid combination (Akhaltsikis Tsiteli Doli, Panonia, Sharbat Sonora and Dwarf varieties) in Karabakh SRB. The variety was submitted to the State Variety Testing in 2018, regionalized in 2021. Patent № 00312.

"Almaz" variety is of medium height (92.8-116.5 cm), resistant to lodging, has a high coefficient of branching (3.4-4.7 pieces), late maturing. In the branching phase, the leaves are hairless, green, free of wax. The spike is cylindrical, white, seed are dark red, belongs to the var. *lutescens*. The spike is long (10.0-12.0 cm), sparse (D = 19.0-23.0). The potential productivity of the "Almaz" variety was 66.5-68.5 c/ha. The average productivity in Nakhchivan SVTC was 37.0 c/ha, in Aghdam SVTC 45.0 c/ha, in Salyan SVTC 42.5 c/ha. The number of grains per spike is 48.7-57.0, the three-year average is 52.2. The 1000 seed weight is 41.8-49.0 g, the amount of protein in the grain can increase up to 15.2-17.3% and the amount of gluten can increase up to 45.0%. Resistant to yellow and brown rust, and powdery mildew.

"Khamsa" bread wheat variety

Authors: Akparov Z.İ., Abdullayev A.M., Rustamov Kh.N., Abbasov M.A., Shikhlinski H.M., Sadigov H.B.

"Khamsa" variety was established in Absheron SRB of the Genetic Resources Institute of ANAS by repeated individual selection from the genotype obtained as a result of the hybridization of bread wheat samples (var. *erythrospermum* x var. *albidum*) selected for complex economic valuable features and submitted to the State variety testing in 2019.

"Khamsa" variety is of medium height (95.0-110.0 cm), intensive type, has a strong stem, highly resistant to lodging. The branching is high, the lifestyle is semi-winter. Spike is straight, long (12.5-13.3), with white colour, has awns, belongs to var. *erythrospermum*. The seed is of medium length, large, red. The potential productivity of the "Khamsa" variety is high 80-90 c/ha. The number

of grains per spike is 48.7-57.0, the three-year average is 52.2. The 1000 seed weight is 41.8-49.0 g, the amount of protein in the grain can increase up to 15.2-17.3% and the amount of gluten can increase up to 45.0%. During the years of research, the variety showed high resistance to yellow, brown rust, and powdery mildew.

"Vilash" bread wheat variety

Authors: Akparov Z.İ., Abdullayev A.M. Abbasov M.A, Rustamov Kh.N., Mehdiyev H.M., Sadigov H.B.

"Vilash" variety was created in Karabakh SRB by repeated individual selection from a complex hybrid combination. In 2019, it was submitted to the State Variety Testing.

“Vilash” variety is of medium height (114.0-118.0 cm), resistant to lodging, has a high branching coefficient, and is late maturing. In the branching phase, the leaves are hairless, green, covered with a weak wax layer. The spikelets are of medium density on the spike axis. The spike of the "Vilesh" variety is cylindrical in shape, white, seeds are dark red, belongs to the var. *lutescens*. The spike is long (11.6-12.6 cm), sparse (D = 22.4-24.2). The number of grains per spike is 48.0-62.1, the three-year average is 56.0. The 1000 seed weight is 40.8-44.5 g. The vitreousness of the grain is high (71.0-100.0%). The amount of protein in the grain can rise up to 11.8-14.9%, gluten - up to 40.0%. The potential productivity of the “Vilash” variety was around 73.0 c/ha. According to the results of the competitive variety testing nursery, the three-year average yield was 64.2 c/ha (62.0; 57.7; 73.0 c/ha), which is 14.7 centners higher than the standard Aran variety (49.5 c/ha).

“Maya” durum wheat variety

Authors: Akparov Z.İ., Abbasov M.A., Sheykhzamanova F.A., Rzayeva S.P., Jafarova R.H., Rustamov Kh.N., Sadigov H.B.

Semi-winter durum wheat variety Maya was established in Absheron SRB in 2009 by re-selection from hybridization of promising durum wheat accessions (var. *melanopus* x var. *horeiforme*). It was submitted to the State Variety Testing in 2015 and regionalized in 2019. Patent № 00250.

Maya variety is a semi-intensive type, medium height (110.0-125.0 cm), highly resistant to lodging. Branches are high (5-6 pieces), semi-winter type, medium ripening. The seedlings are dark green, covered with short hairs. The spike is cylindrical, has awns, of medium length (9.0-10.0 cm), and is dense (D=20.0-22.0), belongs to var. *leucomelan*. Spikelets of medium length are lanceolate and white. The veins are well defined. The awns are 1.5 times longer than the spike, parallel to the spike, slightly scattered, toothless-smooth, black in color, shed when ripe. It is easy to beat. The grains are very large, elongated, white, the vitreousness is 60-98%. Potential productivity is high - 80-90 c/ha, 1000 seed weight is 64.8 g, the net weight is 830.0 g, the number of grains in the main spike is 50.0-51.0. The overall baking quality is low. The amount of protein in the grain is 12-14%, and the amount of gluten is between 24.0-30.0%. Due to the high productive branching (5-6 units), productivity is high when 3.5-4.0 million seeds are sown per hectare. The variety is middle tolerant to winter and drought, tolerant to high temperature, and highly resistant to rust diseases.

"Alliance" durum wheat variety

Authors: Akparov Z.İ., Abdullayev A.M., Rustamov Kh.N., Abbasov M.A., Shikhlinski H.M., Sadigov H.B.

The "Alliance" durum wheat variety was created by repeated individual selection from a complex hybrid combination introduced from CIMMYT. Submitted to the State Variety Testing in 2018, regionalized in 2021. Patent № 00316.

"Alliance" durum wheat variety is of medium height (103.7-109.6 cm), resistant to lodging, and has a high branching coefficient (3.5-4.2 units). In the branching phase, the leaves are light green, hairless, free of wax. Spike is white, cylindrical, has medium-length (9.0-10.0 cm) and density (D = 24.6-26.6 pieces), the seeds are white, belongs to the var. *leucomelan*.

The potential productivity of "Alliance" variety is 76.0 c/ha. Productivity was 36.9 c/ha in Nakhchivan SVTC and 36.0 c/ha in Ismayilli SVTC. The number of grains per spike was 61.4-66.4, the three-year average was 60.4, the 1000 seed weight was 42.0-53.6 g, the amount of protein in the grain was 11.0-15.0%, the amount of wet gluten was 24.2-31.0%. "Alliance" is highly resistant to yellow, brown, and stem rust, and to powdery mildew.

The new varieties are mainly semi-intensive and intensive types, requiring high agronomic background. Cotton and other inter-row crops are more effective predecessors under irrigation conditions.

To get a high and quality product, 90-100 kg/ha of nitrogen (at sowing time and as feeding), 60-90 kg/ha of phosphorus and 50-60 kg/ha of potassium fertilizers should be given. The optimal sowing period is the I-II decade of October. It is recommended to cultivate new varieties in irrigated lowlands and foothills provided with moisture.

CONCLUSIONS

In recent years, at the Karabakh SRB, the resistance to diseases and pests, morphobiological and agronomic traits and characteristics, productivity indicators of bread and durum wheat varieties were studied, and new durum and bread wheat varieties of semi-intensive and intensive type were created.

"Khamsa" and stable hybrid lines are fully suitable for cultivation in a modern, intensive type, high agronomic background. The cultivation of these varieties in artificial rainfall backgrounds with high fertilizer doses is more effective.

The average perennial productivity of the new regionalized “Maya” and “Alliance” durum wheat varieties does not lag behind the bread wheat varieties. The standard deviation indicates that the yield stability of new durum wheat varieties is lower than that of bread wheat varieties.

Seeds of 5 bread (Leyla, Start, Janub, Almaz, Khamsa), 2 durum wheat (Maya, Alliance) varieties submitted to the Agrarian Services Agency under the Ministry of Agriculture of the Republic of Azerbaijan, were multiplied. Seed production of “Maya” durum wheat, “Start” and “Janub” bread wheat varieties were organized.

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Bərk (*T.durum* Desf.) və yumşaq buğda (*T.aestivum* L.) sortlarının aqrobioloji göstəricilərinin Qarabağ bölgəsində müqayisəli təhlili

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Qarabağ bölgəsində AMEA Genetik Ehtiyatlar İnstitutu (GEİ) və Əkinçilik Elmi Tədqiqat İnstitutunda (ƏETİ) çoxillik tədqiqatlarla (2005-2020-ci illər) aparılan seleksiya işləri nəticəsində yaradılmış yeni perspektiv buğda sortlarının aqrobioloji xüsusiyyətləri müqayisəli tədqiq olunmuşdur. Yüksək adaptivliyə malik və potensial məhsuldarlığı ilə fərqlənən "Leyla", "Start", "Cənub", "Xəmsə", "Almaz", "Oğuz", "Viləş" yumşaq buğda və "Maya", "Alyans" bərk buğda sortları yaradılmışdır. Onlardan yumşaq buğdanın "Start" (patent № 00246), "Cənub" (patent № 00274), "Leyla" (patent № 00305) və "Almaz" (patent № 00312) sortları, bərk buğdanın "Maya" (patent № 00250) və "Alyans" (patent № 00316) sortlarına Aqrar Xidmətlər Agentliyi tərəfindən patent verilərək rayonlaşdırılmışdır. Müsabiqəli sort sınağı pitomnikində tədqiq olunan sortların boy göstəriciləri, məhsuldarlığı və onun struktur elementləri, pas xəstəliklərinə davamlılığı və adaptivliyi analiz edilmişdir. Epifitotiya ilində (2020-ci il) bərk buğda sortları və "Almaz" və "Xəmsə" yumşaq buğda sortları sarı pasa davamlı olmuşlar. Məhsuldarlığa və onun struktur elementlərinə görə də önəmli fərq müşahidə edilmişdir. Bundan başqa yeni bərk və yumşaq buğda sortları morfobioloji və aqronomik əlamət və xüsusiyyətlərinə görə səciyyələndirilmişdir. Rayonlaşdırılmış sortların optimal becərilmə texnologiyası, sələfləri, gübrə normaları və səpin müddəti verilmişdir. Yeni sortların Qarabağ bölgəsinin suvarılan düzən və nəmliklə təmin olunan dağətəyi bölgələrində becərilməsi tövsiyə olunur.

Açar sözlər: *Bərk buğda, yumşaq buğda, sarı pas, qonur pas, sort, məhsuldarlıq, davamlılıq*

Сравнительный анализ агробиологических показателей новых сортов твердой (*T. durum* Desf.) и мягкой (*T. aestivum* L.) пшеницы в Карабахском регионе

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В Карабахском регионе было проведено сравнительное изучение агробиологических показателей новых сортов твердой и мягкой пшеницы, созданных в результате многолетних (2005-2020 гг.) исследований в Институте генетических ресурсов НАНА и НИИ Земледелия. Были созданы отличающиеся потенциальной продуктивностью и высокой адаптивностью сорта мягкой пшеницы «Лейла», «Старт», «Джануб», «Хамса», «Алмаз», «Огуз» и «Вилаш», а также сорта твёрдой пшеницы «Майя» и «Альянс». Агентством аграрных услуг были выданы патенты и районизированы сорта мягкой пшеницы «Старт» (патент № 00246), «Джануб» (патент № 00274), «Лейла» (патент № 00305) и «Алмаз» (патент № 00312), а также сорта твердой пшеницы «Майя» (патент № 00250) и «Альянс» (патент № 00316). В питомнике конкурсного сортоиспытатания были проанализированы показатели

высоты растений, урожайность и ее структурные элементы, устойчивость к желтой и бурой ржавчине и адаптивность. В эпифитотийном 2020 году сорта твердой пшеницы, а также сорта мягкой пшеницы «Алмаз» и «Хамса» оказались устойчивыми к желтой ржавчине. Значительные различия наблюдались также по урожайности и ее структурным элементам. Кроме того, проанализированы морфо-биологические и агрономические признаки и свойства новых сортов твердой и мягкой пшеницы. Приведены оптимальные агротехнические приёмы выращивания, предшественники, нормы удобрений и сроки посева новых сортов. Новые сорта рекомендованы для выращивания на орошаемых равнинных и в обеспеченных влагой предгорных богарных условиях Карабахского региона.

Ключевые слова: *Пшеница твёрдая, пшеница мягкая, жёлтая ржавчина, бурая ржавчина, сорт, урожайность, устойчивость*

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Thermophilic bacteria of the hot springs "Ashagi Istisu" and "Yukhari Istisu" of the Kalbajar region of the Republic of Azerbaijan

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The presented work is devoted to the study of the bacterial biota of the hot springs "Ashagi Istisu" (pH=8.0, t=64°C, mineralization is 6.7 g/l) and "Yukhari Istisu" (pH=9.0, t=71°C, mineralization is 4.3 g/l) of the Kalbajar region, characterized by a wide range of environmental conditions (pH, temperatures, chemical components, etc.). Samples of thermal waters were inoculated and colonies of thermophilic bacteria that grew on a solid medium of nutrient agar were isolated. Some colonies of thermophilic bacteria were isolated in pure culture and 6 strains were received (KA_1, KA_2, KA_3, KY_1, KY_2, KY_3). The cell morphology of these strains is represented by short and long gram-positive, spore - forming rods, varying in size. Colonies differ in color, shape, margin, consistency, size, etc. The morphology of cells and colonies of two strains (KA_1, KY_1) has been well studied, and the ratio of these strains to the pH and temperature of the medium was determined. It was found that strains KA_1, KY_1 actively grow in the temperature range 55-60°C, at pH=7.0-9.0. Based on morpho-cultural characteristics and some physiological properties, the strains were identified. The KA_1 strain was assigned to the genus Bacillus, and the KY_1 strain was presumably assigned to the Bacillus stearothermophilus species.

Keywords: *Hot springs, thermophilic bacteria, morpho-cultural characteristics*

INTRODUCTION

Kalbajar region is one of the most beautiful regions of Azerbaijan, distinguished by its climatic conditions and natural wealth. Kalbajar is an integral part of Azerbaijan, the highest mountainous region, located at the height of the Jamyshdag mountain (3724 m). In 1993 Kalbajar was occupied by Armenian armed bandit formations (Kamal, 2012). But, based on the trilateral agreement signed on November 10, 2020, the Kalbajar region again came under the control of Azerbaijan. Azerbaijani President Ilham Aliyev said, that the authorities will restore the Kalbajar region, which has come under the control of Baku according to the trilateral agreement on Karabakh including the "Istisu" resort zone. The Istisu spring is worthy of a separate mention the "living water" of the spring unique in its properties has cured and brought back to life millions of people (Гасанов, 1978). The spring is located on the slopes of mountain ranges in the west of Kalbajar, at an altitude of 2225 meters above sea level. The water here is hyperthermal, hydrocarbonate – sulphate – chloride - sodium, carbonated (Трешников, 1983). There are 12 water springs in total, which have a curative effect on internal and external human diseases. In 1980 a mineral water collection plant and a large resort were built here. In the village of Istisu in the former USSR, sanatoriums of All-Union significance worked which every year received 50.000 people. The water of the Istisu spring attracts the attention of scientists from all over the world. It was noted that in terms of its physical characteristics and composition this water is close to water from the Czech Republic (Karlovy Vary) and in some parameters the water has no analogues in the whole world (Ахмедова и др., 2016). The springs of Istisu with therapeutic and sickleological influence include Yukhari Istisu, Ashagi Istisu, Keshdag, Garasu, Tutkhun, Mozchay, which glorified Kalbajar (Гасанов, 1978). Istisu thermal springs also attract

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the attention of microbiologists due to their unique microbiota. It is known that hot springs are natural habitats for thermophilic microorganisms (Adiguzel et al., 2009, 2011; Khiyami et al., 2012; Verma et al., 2014; Akhmedova, 2021). Investigations of thermophilic microorganisms of the Istisu springs were systematically and fruitfully carried out many years ago (Əhmədova, 2007).

Knowledge of the qualitative composition of the microbiocenosis of hot springs is extremely important for the assessment and effective control of their condition while the study of the biological characteristics of the main representatives of microorganisms contributes to the knowledge of the thermophilic group (Əhmədova, 2007; Quliyeva, 2015).

Thermophilic microorganisms are one of the most practically significant groups of microorganisms since they have several properties such as thermal stability, resistance to ionizing radiation, fast cultivation time, wide distribution, etc. (Логинова и др., 1966; Ахмедова, 2007; Souza et al., 2001; Robb et al., 2008; Khalil, 2011). Therefore, the use of thermophilic microorganisms in various spheres of human activity is currently an urgent trend in microbiology (Burgess et al., 2010; Kawasaki et al., 2012; Aanniz et al., 2015; Baltaci et al., 2017).

Known strains of thermophilic bacteria are highly resistant to radiation and are widely used in practice due to this ability. An example is *Deinococcus radio*durans an extremophile that is one of the most radiation-resistant in the world, capable of surviving doses up to 10000 Gy. Due to this ability, it is used for bioremediation of radioactive waste (Mattimore et al., 1996; Lin et al., 1999; Brim et al., 2000; Makarova et al., 2001; Levin-Zaidman et al., 2003; Cox et al., 2005). Thermophilic anaerobic bacteria which have their powerful hydrolases are used in the production of ethanol which significantly speeds up the process since the stage of preliminary hydrolysis of raw materials is excluded and a high cultivation temperature increases the reaction rate (Захарук, 2018; Kublanov et al., 2009; Abdel-Banat et al., 2010; Tobler et al., 2011; Obeidat et al., 2012; Bakshaliyeva et al., 2019). Thermophiles are also used to accelerate chemical reactions in wastewater treatment at petrochemical enterprises in the disposal of animal corpses in thermal pits to ensure the biological safety of territories and the population of the Arctic zone (Ксенофонтов, 2010; Арьков, 2016; Золотухин, 2018; Tango et al., 2002). Some scientific works talk about the synthesis of vitamin B_{12} for the needs of animal husbandry using a mixed culture that includes thermophilic microorganisms (Evelyne et al., 1998; Martens et al., 2002). This makes it possible to talk about thermophiles as a component of drugs in pharmacology (Махмутова, 2017). Known scientific works talk about the extraction of copper in industrial reactors using thermophilic bacteria. Therefore, we can judge the use of thermophilic bacteria in the metal mining industry (Rodrigues et al., 2015).

Thermophilic bacteria are also used in nanobiotechnology in the green synthesis of metal nanoparticles. In practice, this method mainly produces silver nanoparticles, which are widely used in medicine and have antibacterial properties (Feng et al., 2000; Sharma et al., 2009; Sinha et al., 2009; Wei et al., 2015; Deljou et al., 2016; Gunashova et al., 2021).

The aforementioned unique properties of thermophilic microorganisms as well as many different spheres of human activity in which thermophilic microorganisms can be applied show how important it is for modern science to isolate and study thermophilic bacteria from their natural habitat-hot springs.

MATERIALS AND METHODS

For isolating the culture of thermophilic bacteria the object of the study was the hot springs "Ashagi Istisu" (pH=8.0, t=64°C) and "Yukhari Istisu" (pH=9.0, t=71°C) of the Kalbajar region. The material was collected from hot springs in April 2021, samples were obtained with the help of the military personnel of the Kalbajar region. The collected samples were stored at a temperature of +5°C, after which they were inoculated on a nutrient medium with meat-peptone agar. Sowing of natural material was carried out on an agar medium of the following composition: meat extract - 1g/l, peptone - 5 g/l, NaCl - 5 g/l, agar - 15 g/l. The cultivation was carried out at a temperature of 60°C for 4-5 days. To obtain a pure culture of thermophilic bacteria the Koch method was used as well as the mechanical method of repeated subcultivation on the medium of meat-peptone agar (Нетрусов, 2005). Study of the

morphology of isolated strains of bacteria by methods microscopy was performed using a light microscope (XSP-30 series microscope). The preparations were prepared using standard methods (Егорова, 1995; Ившина, 2014; Лавренчук и др., 2019).

The strains were also cultured on a meat-peptone agar medium supplemented with 0.2 g/l of yeast extract. Yeast extract was not required for growth, but the addition stimulated growth significantly.

To determine the ratio of strains to temperature cultivation was carried out in the temperature range 40-70°C using a set of thermostats set at different temperatures. The diameter of the grown colonies was used to judge the optimum temperature for the growth of strains. To determine the ratio of the isolated strains to pH the strains were inoculated on meat-peptone agar media with different pH values of the medium (6.0-10). The growth pH range was determined at the optimum growth temperature. The diameter of the grown colonies was used to judge the optimal pH value for a given strain (Теппер и др., 2004).

Some strains were identified based on morpho-cultural characteristics and some physiological properties (pH, t°C) (Логинова и др., 1996).

RESULTS AND DISCUSSION

As a result of the study, 3 strains of thermophilic bacteria were obtained from a water sample taken from “Ashagi Istisu” (KA$_1$, KA$_2$, KA$_3$) and 3 strains from a water sample from “Yukhari Istisu” (KY$_1$, KY$_2$, KY$_3$). The cell morphology of the isolated strains is represented by short and long gram-positive, spore-forming rods, varying in size. Differences in cultural characteristics are noted. Colonies are mainly cream and beige in color, small, large, and medium-sized, round, irregular, and rhizoidal in shape, also differing from each other in the consistency, at the edges, in surface structure, etc. So far, only 2 of the isolated strains (KA$_1$, KY$_1$) have been well studied, so we will show the morpho-cultural traits and physiological properties (pH, t°C) of these two strains. The morphological and cultural characteristics of the KA$_1$ and KY$_1$ strains are shown in Fig.1 and Fig. 2, respectively (Table1).

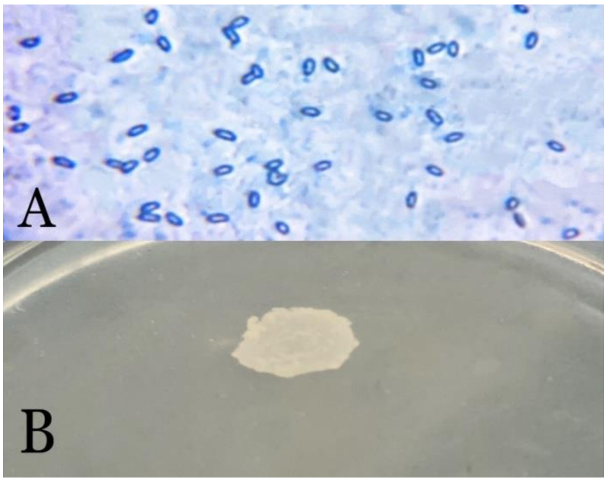


Fig. 1. A: Morphology of cells of the KA$_1$ strain under a microscope (magnification x1000); **B:** Morphology of the KA$_1$ strain colony (cultivation was carried out at 60°C, within 2 days)

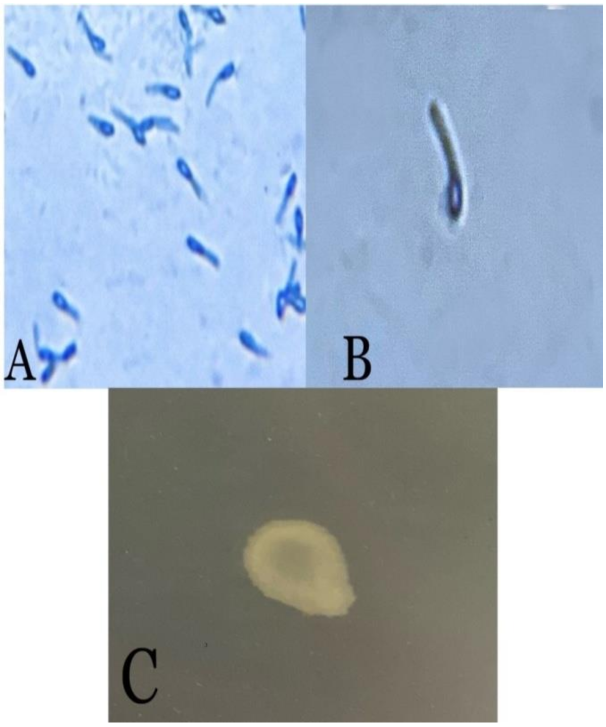


Fig.2. A: Morphology of cells of strain KY$_1$ under a microscope (magnification x1000); **B:** single cell of strain KY$_1$ (magnification x100); **C:** Colony morphology of strain KY$_1$

Table 1. Morpho-cultural characteristics of KA_1 and KY_1 strains.

Strains	Cultural traits					Morphology of cells	
	Shape	Size, cm	Color	Margin	Elevation	Shape	Motility, size, micrometer (μm)
KA_1	Round	1	Cream	Undulate (wavy)	Raised	Rods	Motile 0.5-0.6x0.9-1.5
KY_1	Irregular	1.5	Beige	Undulate (wavy)	Convex	Rods (with terminal spores)	Motile 0,3-1,2 x 1,5-4

Were studied some physiological properties (pH, t°C) of the KA_1 and KY_1 strains. It was found that strains KA_1 and KY_1 actively grow in the temperature range 55-60°C, at a pH value (7.0-9.0). The strains were identified based on morpho-cultural characteristics and some physiological properties. The KA_1 strain was assigned to the genus Bacillus, and the KY_1 strain was presumably assigned to the Bacillus stearothermophilus species.

CONCLUSION

Isolation and study of thermophilic bacteria from their natural habitat, hot springs, is one of the most urgent problems in modern science due to the widespread use of these bacteria in various fields of human activity, also in nanobiotechnology, in the green synthesis of metal nanoparticles. This paper investigates the isolation of thermophilic bacteria from the hot springs of the Kalbajar region, "Ashagi Istisu" and "Yukhari Istisu". Only 6 strains of thermophilic bacteria were isolated, 2 of which are well studied and the morpho-cultural characteristics of these strains have been described. The ratio of these strains to the pH of the medium and temperature was also determined, and the range of optimal values of pH and temperature for the growth of these strains was established. Based on the above studies the strains were identified and assigned to the genus Bacillus. Research in this direction continues.

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Azərbaycan Respublikasının Kəlbəcər rayonunun "Aşağı İstisu" və "Yuxarı İstisu" su mənbələrinin termofil bakteriyaları

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Təqdim olunan elmi işdə Kəlbəcər rayonunun ekoloji şəraiti ilə (pH, temperatur, kimyəvi komponentləri və s.) səciyyələnən "Aşağı İstisu" və "Yuxarı İstisu" termal su mənbələrinin bakteriyal biotası öyrənilmişdir. Termal su nümunələri ətli-peptonlu aqar qidalı mühitində becərilmiş, inkişaf edən koloniyalar təmiz kulturaya çıxarılaraq 6 termofil bakteriya ştamı alınmışdır (KA_1, KA_2, KA_3, KY_1, KY_2, KY_3). Bu ştamların hüceyrələrinin

morfoloji görünüşü bir birindən ölçüləri ilə fərqlənən qısa və uzun çöp şəkilli olub, spor əmələ gətirmək qabiliyyətinə malik olublar. Koloniyaları formasına, ölçüsünə, quruluşuna və s. kultural əlamətlərinə görə bir- birindən fərqlənirlər. KA_1, KY_1 saylı ştamlar morfo-kultural əlamətlərinə görə daha geniş öyrənilməklə yanaşı, onların mühitin temperaturuna və pH-na münasibəti də araşdırılmışdır. Müəyyən olunmuşdur ki, ştamların optimal inkişaf temperaturu 55-60ºC, pH=7.0-9.0 arasında tərəddüd edir. Aparılan tədqiqatlar nəticəsində KA_1, KY_1 ştamları identifikasiya edilmişdir. Belə ki, KA_1 ştamı Bacillus cinsinə aid edilmiş, KY_1 ştamının isə Bacillus stearothermophilus növünə aid olduğu ehtimal edilmişdir.

Açar sözlər: *Termal su mənbələri, termofil bakteriyalar, morfo-kultural əlamətlər*

Термофильные бактерии водных источников «Ашагы Истису» и «Йухары Истису» Кельбаджарского района Азербайджанской Республики

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В работе представлены данные по исследованию бактериальной биоты термальных водных источников «Ашагы Истису» (pH=8.0, t=64^0C, уровень минерализации-6.7 г/л) и «Йухары Истису» (pH=9.0, t=71^0C, уровень минерализации-4.3 г/л) Кельбаджарского района, характеризующихся широким диапазоном экологических условий (pH, температур, химических компонентов и др.). Был сделан посев образцов термальных вод и выделены колонии термофильных бактерий, выросших на твердой среде из мясо-пептонного агара. Некоторые колонии термофильных бактерий были выделены в чистую культуру, в результате чего получили 6 штаммов (KA_1, KA_2, KA_3, KY_1, KY_2, KY_3). Морфология клеток этих штаммов представлена короткими и длинными грамположительными, спорообразующими палочками, варьирующими в своих размерах. Колонии отличаются между собой по цвету, форме, краям, консистенции, размерам и т.д. Морфология клеток и колоний двух штаммов (KA_1, KY_1) хорошо изучены, а также определено отношение этих штаммов к pH и температуре среды. Установлено, что штаммы KA_1, KY_1 активно растут в интервале температур 55-60ºC, при значениях pH =7.0-9.0. На основе морфо-культуральных признаков и некоторых физиологических свойств, штаммы были идентифицированы. Штамм KA_1 был отнесен к роду Bacillus, а штамм KY_1 предположительно отнесли к виду Bacillus stearothermophilus.

Ключевые слова: *Термальные источники, термофильные бактерии, морфо-культуральные признаки*

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Diversity of the *Triticeae* genetic resources in the Karabakh region of Azerbaijan

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This paper gives an overview of the collection history for the species from the *Triticeae* Dum. tribe in the Karabakh region of Azerbaijan up to date of its occupation. By covering most of the Lesser Caucasus with the semi-desert and dry steppe climate, the Karabakh region of Azerbaijan has favorable conditions for grass diversity. There are 14 genera from the tribe *Triticeae* in Azerbaijan, of which historically the 10 genera also were found in the Karabakh region. The data in this article have been presented as a summary of information recorded in different literature sources, that would be useful for the planned monitoring of status, distribution, and preserving issues for the *Triticeae* species in the liberated areas.

Keywords: *Karabakh region of Azerbaijan, Triticeae tribe, Aegilops* L.*, Triticum* L.*, Hordeum* L.*, Secale* L.*, Agropyron* L.*, wild cereals*

Epigraph: **“***A peculiar species and varietal composition of plants, including a number of endemic forms, makes the Karabakh an area for further, more detailed study.***”**

Vavilov N.I., 1957

The Karabakh region of Azerbaijan. The Karabakh region (the name is originated from the connection of two Azerbaijani or Turkish words “Qara” – black, large, leader, dark, dense, impenetrable, picturesque, etc. and “Bağ”- garden) is located in the southwestern part of Azerbaijan extending from the highlands of the Lesser Caucasus down to the lowlands between the rivers Kur and Araz. This area of Azerbaijan was always represented by high biodiversity and geodiversity, as well as by agronomical and historical conditions (Əsgərov, 2021; Əsgərov və b., 2021; Hüseynova, 2021; Qurbanov, 2021; Mehdiyeva, 2021; Məsiyeva, 2021). Initial assessments of liberated territories of Karabakh region, after the Azerbaijan Patriotic War (27.09.2020 – 10.11.2020), showed that 30 years of Armenian occupation, the military operations initiated by occupants, the prohibited weapons used by them, and barbaric usage of natural resources resulted in extensive suffering of all the above-mentioned conditions of the region. The Azerbaijani authorities planned to allocate 2.2 billion manats (1.3 billion dollars) for the reconstruction of the territories of Karabakh, which returned under their control. To facilitate the restoration of the returned territories, the area was divided by government officials into two regional economic zones with its inclusive districts starting from the 7th July 2021: Karabakh region with an area of 7330 km^2 (Khankendi, Aghjabadi, Aghdam, Barda, Fuzuli, Khojalı, Khojavend, Shusha, Tartar) and the Eastern Zangazur region with an area of 7448 km^2 (Jabrayil, Kalbejar, Qubadli, Lachin and Zangilan). Western Zangazur (Gafan, Ghorus, Garakilse, Mehri) was torn from Azerbaijan and handed over to Armenia by the Soviet government in 1920 as a result of historically recurring periodic

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territorial claims of the aforementioned second country.

Climate of the Karabakh region. Karabakh region belongs to a semi-desert and dry steppe climate with low humidity, warm winters, dry and hot summers. According to the temperature regime, it belongs to the subtropical (average annual temperature is 13-14.5ºC), but according to the conditions of moisture in most of it - to the semi-desert, and in the foothill zone - to the dry-steppe (Мирзазаде, 2021). In places located above 2000-2300 meters, there are alpine and subalpine meadows. The average annual precipitation is about 400 mm, in high mountains, it is more than 800-900 mm. The duration of sunshine is 2000-2400 hours per year. The average temperature of the coldest months (January, February) does not exceed 2.5–0ºC or 0-5ºC. The average temperatures of the hottest months July and August are 25.50ºC and 25.20ºC, subsequently. In warm seasons (April-October), the possible evaporation is in the range of 400-800 mm. In June-September, the number of dry days ranges from 5 to 25 or less. The average annual wind speed is 2-3 m / second or less. The continentality of the climate fluctuates within the following limits: weak (less than 130), moderate (up to 165), and medium (up to 205). The duration of frost-free temperatures is 150-225 days a year, the air temperature below 0ºC throughout the territory lasts in the range of 10-100 days and is 10-50 days - in Jabrayil, Fuzuli, Khojavend, Aghdam, and Tartar, 20-50 days - in Khojaly and Khankendi, 50-100 days - in Shusha. In most areas, the snow cover does not melt for 10-120 days.

Soil types of Karabakh region. Karabakh covers most of the Lesser Caucasus (81.5%). The results of large-scale soil studies show that in the mountainous areas of the Karabakh region they are presented by primitive mountain - meadow, soddy mountain meadow, forest mountain meadow, dark mountain meadow, chernozem like mountain meadow, typical forest mountain brown, forest carbonate mountain brown, mountain forest brown typical, mountain meadow steppe, mountain forest brown cultivated, gray-brown mountain dark, mountain forest brown leached, mountain forest brown steppe, mountain chestnut dark soils, and in the plains the following types and subtypes were found: chestnut ordinary, chestnut long irrigated, meadow chestnut, gray, dark gray, gray typical, gray irrigated, gray meadow-meadow, floodplain meadow (alluvial meadow), chestnut dark soils. Distribution of areas by soil categories (according to data of 1992) (Ахадов, 2021):

1. Agricultural soils - 336742 ha;
2. The lands of settlements are only 5592 ha;
3. Lands of industry, transport, communications, defense, and other categories;
4. Lands of specially protected areas are 43947 ha;
5. Forest fund - 246187 ha;
6. The total land area of the water fund was 19,800 ha.

Vegetation cover of the Karabakh region. The vegetation of the Karabakh region (including the Karabakh steppe) is very diverse in composition, which reflects both the difference in ecological conditions and evolutionary changes. The main type of vegetation is the semidesert wormwood. Large areas are occupied by solonchak groupings, as well as meadow ones. Locally, forest vegetation is also represented in the form of tugai and lower forests, in places, shrubs, and there is also marsh vegetation. More than 2000 plant species are found in the area of vegetation. On the plains, a huge place is occupied by thickets of wormwood and other semi-desert plant species, on the soles of the mountains, steppe and steppe plant species prevail, on the slopes of the mountains there are shrubs and deciduous forests (pistachio, oak, etc.). Before Armenian occupation this region had 2 nature reserves - Basitchay Government Reserve, founded in 1974 with area equal to 107 ha in Zangilan district and Garagol Government Reserve founded in 1987 with area equal to 240 ha in Lachin district, and 4 wildlife sanctuaries (Lachin Government Sanctuary (founded in 1961 with area equal to 21.4 ha), Gubadli Government Sanctuary (founded in 1964 with an area equal to 20 000 ha), Dashalti Government Sanctuary (founded in 1988 with area equal to 450 ha) and Arazboyu Government Sanctuary (founded in 1993 with an area equal to 450 ha). All of these mentioned reserves and sanctuaries were founded by the decision of the government of Azerbaijan USSR.

Collection of cereals from the *Triticeae* tribe in the Karabakh region. The *Triticeae* tribe is the taxon within the subfamily *Pooideae* of grasses with the most economically important cereals (wheat, barley, rye, etc.), including 27 genera

and 501 species (Soreng et al., 2015), many of which have been domesticated, used in human consumption, animal feed or rangeland protection. Here, we presented the data about the distribution of species from the *Triticeae* tribe in the Karabakh going back to more than 30 years ago, as the collapse of the USSR and following the subsequent territorial claims of Armenia slowed down and nullified research works in these territories long before of their occupation. While presenting the data about cereal plants of the Karabakh, in order to avoid confusion related to their classification, we followed here taxonomic names and divisions accepted by the source literature, as well as the recent work of Asgerov (2016) about the land plants of Azerbaijan, where the *Triticeae* Dum. tribe indicated as having a total of 20 genera. Should be noted, that we did not present here the plant species distributed in the small part of the Karabakh, which covers the Kur-Araz Lowland as the information about cereals from this area was not engaged to the certain places in the appropriate literature.

***Triticum* L.** Cultivated wheat and its close wild relatives belong to the genus *Triticum* L. There is a mention in the literature about turgidum wheat collections in the territory of Azerbaijan going back to 1844 and related with the name of Czech-German botanist and zoologist – F.A.Kolenati (Dorofeev, 1972). But the more extensive studies of this genus in Azerbaijan are related with the names of such scientists as L.L.Dekaprelevich (1924), N.N.Kuleshov (1927), K.A.Flyaksberger (1935), M.M.Jakubciner (1932, 1933б), I.D.Mustafayev (1959, 1961, 1964, 1967, 1969, 1970, 1973, 1980), V.F.Dorofeev (1972) etc.

Wild taxa of the genus *Triticum* L. (*T. urartu* Thum. ex Gandil. and *T. boeoticum* Boiss.) are occurring in the Middle East and South Caucasus (Transcaucasus) region, including Azerbaijan. For the Azerbaijan territory, the wheat species *T. boeoticum* was recorded for the first time by Jakubciner M.M. in 1932 from the Nakhichevan region. For the Karabakh region of Azerbaycan, for the first time, it was reported by Mustafayev I.D. (1957-1963) from Zangilan and Jabrayil districts. According to him, the polymorphism of this species in Karabakh was presented by 11 botanical varieties from a total of 22 occurred in Azerbaijan (Table 1), of which 4 (var. *pseudoalbum*, var. *reuteri*, var. *balansae*, var. *fuscum*) were common also for the Nakhichevan region and 1(var. *reuteri*) also for Shamakhi (Mustafayev, 1973). The remaining 10 botanical varieties that were uncommon for the Karabakh occurred only in the Nakhichevan region and 1 in the Shamakhi district of Azerbaijan. V.F.Dorofeev in his work presented the image of *T. boeoticum* thickets from the Aghoglan district (Banazar villiage) of Karabakh (Figure 1) without indicating its botanical data. If *T. boeoticum* was found at the 3 locations in Karabakh, the other wild wheat *T. urartu* was found also by Mustafayev only in one location – Zangelan district. He included these accessions into 2 botanical varieties: var. *spontanobrum* and var. *spontaneonigrum*. The second location for this species in the Azerbaijan territory is the Nakhichevan region (Əsgərov, 2016). *T. boeoticum* and *T. urartu* are considered as the donor of the A subgenome of modern wheat, harnessing broad genetic diversity for a number of traits including disease resistance, phenology, and morphology traits (Taheri et al., 2018; Talini et al., 2020). Therefore, its populations from indicated districts of Karabakh, as very valuable genetic sources, should be re-monitored and preserved.

The ancestral wheat *T. monococcum* L., diploid wheat whose A^mA^m genome is closely related to the A^u genome of *T. urartu* and the polyploid wheat, was domesticated from its wild form (*T. monococcum* ssp. *boeoticum*) about 12,000 years ago in the Karacadagh mountains (Marino et al., 2018). The first report about this species from the territory of Azerbaijan was made by N.N.Kuleshov in 1926. This species was cultivated widely in Shusha, Khankendi, Lachin, and several other mountains districts of Garabgh before 1930, but later started to be replaced by other naked wheat that considered to be more productive (Мустафаев, 1973). V.N.Vavilov (1964) defined 2 ecogeographical groups for the cultivated einkorns of Transcaucasia: proles *armeno-anatolicum* Vav. (small-sized spikes and leaves, thin stems) and proles *carabachicum* Vav. (large-sized spikes (8-9 cm) with the spikelets not infrequently having the two grains, wide leaves, long, strong and erect stems, which is hollow under the ear), but later L.L.Dekaprelevich added another 2 morpho-ecological types: *occidentale-georgicum* Dek. (close to the proles *carabachicum*) and *orientale-georgicum* Dek., which differentiates from the first type also by its weak growth, small spikes, and a short vegetation period (Dorofeev, 1972). Differing from the proles *armeno-*

anatolicum Vav., the plants from the proles *carabachicum* reminded Spanish samples by their habitus, presented only by the spring types with the mid-ripening date, and in harsh contrast with the aforementioned first proles, being very resistant to many diseases, they were comparatively susceptible to the hard smut (Vavilov, 1964). It was noted about the high agricultural culture in the Karabakh region. The local population regularly and annually selected the most productive spikes for sowing. Vavilov suggested, that the south part of the Karabakh region generated the most diversity of cultivated einkorn wheat, which were observed in the mixed communities with the emmer wheat (Vavilov, 1962). All forms of cultivated einkorn wheat *T. monococcum* in the territory of Azerbaijan belongs to the one ecogeographical group – proles *carabachicum* Vav. According to morphological polymorphism, Mustafayev defined 9 botanical varieties and 1 form for Azerbaijani populations of this species, of which 8 were described for the accessions from the Karabakh region (Мустафаев, 1973) (see Table 1).

The hulled wheat species *T. dicoccum* (Schrank) Schuebl. (=*T.turgidum* ssp. *dicoccon* (Schrank) Thell.) was cultivated in many regions of Azerbaijan, including Karabakh, starting from ancient times, information about its winter and spring farming fields in Khankendi, Shusha, and Lachin districts was traced in literature by Mustafayev until 1973. According to Vavilov (1964), this hulled wheat from Karabakh belongs to the eco-geographical group – proles *carabachicum* of subsp. *asiaticum* Stoletova (Asian subspecies). They differ from plants of proles *armeno-anatolicum* by late- ripening, large-sized spikes, and grains, large-sized spikelets, as well as the more strong stem and by resistance to the stripe and yellow rust (Vavilov, 1964). Mustafayev indicated the distribution of 4 subspecies and 24 botanical varieties for the territory of Azerbaijan, of which 21 from all mentioned 4 subspecies were described for Karabakh (Мустафаев, 1973) (see Table 1). It should be noted that subspecies *turgidoides* with its 10 botanical varieties registered by Mustafayev for the first time based on the accessions collected from districts of Karabakh. This species was widely used in interspecific and intergeneric hybridization works carried by him.

Durum wheat *T.durum* Desf. (syn. *T. turgidum var. durum* Desf.) and turgidum wheat *T. turgidum* L. also has a long history of cultivation in Azerbaijan, but mainly as a winter type. Most forms of durum and turgidum wheat in Transcaucasia were recorded for Azerbaijan, where they were characterized by wide morphological polymorphism because of their distribution in the wide range of altitude, for durum wheat between -16 to 1870 m above sea level. Classification of durum wheat in Azerbaijan was carried by P.E.Grebennikov (1948) and I.D.Mustafayev (1970). According to I.D.Mustafayev and L.V.Kadisheva (1970), all durum wheat species of Azerbaijan should be divided into 3 ecomorphological groups (*proles*) with their own subgroups (*subproles*) and forms: *azerbajdzhanicum* I.Must. et L.Kovd., *durocompactum - stepposum* I.Must. et L.Kovd. and *durooblongatum - silvaticum* I.Must. et L.Kovd. Taxonomically, all forms of durum wheat of Azerbaijan were included in 3 subspecies: *expansum* Vav., *horanicum* Vav. and *falcatum* Jakubz. and 33 botanical varieties, of which 20 were distributed in Karabakh. Among the regions of Azerbaijan, the richest one for the durum wheat botanical diversity is considered to be the Shirvan region. Turgidum wheat of Azerbaijan was included in subspecies *mediterraneum* Vav. and 2 ecomorphological groups: *proles capsicum* Vav. (mainly winter types and most distributed) and *proles orientale* Flaksb. (mainly spring type and less distributed). From a total of 40 botanical varieties of this species found in Azerbaijan, only 5 was recorded for the Karabakh region (Мустафаев, 1973) (Table 1).

Ancient wheat species *Triticum persicum* Vav. (=*T. carthlicum* Nevski) accessions collected from Azerbaijan were included in 6 botanical varieties, from Georgia – into 5, from Armenia – into 2. Total botanical varieties for the South Caucasia (Transcaucasia) is 11with the most distributed 3: *atramineum*, *rubiginosum*, and *fulliginosum*. In Karabakh occurred only 3 from 6 distributed in Azerbaijan (Мустафаев, 1973) (see Table 1).

Polish wheat *T. polonicum* L. (=*T. turgidum* ssp. *polonicum* L. (MacKey)) found in Azerbaijan were included in subsp. *mediterraneum* with 5 botanical varieties, of which 2 occurred in Karabakh (Мустафаев, 1973) (see Table 1). This species was suggested to have more desirable sensory properties than the products made with the flour of common wheat and durum wheat (Suchowilska et al., 2019).



Fig. 1. Thickets of wild wheat *T. boeoticum* Boiss. in Aghoglan district of the Karabakh region, Azerbaijan (Dorofeev, 1972)

Table 1. Accessions collected during different expeditions conducted in the Karabakh region of Azerbaijan

Species	Location
***Triticum* L.**	
T. boeoticum Boiss.	
(*T. boeoticum* Boiss. ssp. *aegilopoides* Bayle. var. *pseudoal-bum*)	
var. *pseudoalbum*Thum.	Zangilan, Jabrayil
var. *pseudozuccarinii* Kovarsk.	Zangilan
var. *mayssuriani* Zhuk.	Zangilan
var. *pubescentinigrum* Flaksb.	Zangilan
?	Aghoglan (Banazar viliage)
***(T. boeoticum* Boiss. ssp. *thaoudar* (Reut) Flaksb.)**	
var. *reuteri* Flaksb.	foothills of Jabrayil
var. *balansae* Flaksb.	Zangilan, Jabrayil
var. *balaclavicum* Kovarsk.	Zangilan
var. *fuscum* Zhuk.	Zangilan, Jabrayil
var. *mazettii* Flaksb.	Zangilan
var. *zangilanicum* Must.	Zangilan
var. *luteinigrum* Kovarsk.	Zangilan
***T.urartu* Thum.exGandilyan** ***(=T. boeoticum*Boiss. ssp. *urartu*Thum.)**	Zangilan
var. *spontanobrum* Thum.	Zangilan
var. *spontaneonigrum* Thum.	Zangilan
●*T. monococcum* L. (proles *carabachicum* Vav.)	
var. *laetissimum* Körn.	farming fields of mountains districts
var. *macedonicum* Papag.	Shushakend, Lachin, Khankendi
f. *eredvianum* Zhuk.	Khankendi (Garov viliage)
var. *pseudoflavescens* Flaksb.	Lachin and other farming fields of mountains districts
var. *vulgare* Körn.	Khankendi (Shushakend viliage)
var. *atriaristatum* Flaksb.	Lachin
var. *albohornemanii* Flaksb.	Lachin, Khankendi
var. *hornemanii* Clen.	Khankendi (Garov viliage)
var. *pseudohornemanii* Dek. et. Men.	Khankendi (Garov viliage)
● *T.dicoccum* (Schrank) Schuebl.	
ssp. *europaeum* (Perc.) Vav. proles *tardoeuropaeum* Flaksb.	Lachin, Khankendi, Shusha, Aghdara
var. *hybridum* Körn.	Lachin
var. *farrum* Bayle.	Khankendi, Shusha
var. *rufum* Schubl.	Lachin
var. *pseudorufum* Flaksb.	Lachin
var. *semicanum* Körn.	Lachin, Khankendi
var. *pseudoerythrurum* Must.	Aghdara
var. *macratherum* Körn.	Lachin, Khankendi
var. *atratum* Körn.	Lachin, Khankendi, Aghdara
ssp. *euroum* Flaksb. proles *transcaucasicum* Flaksb.	Khankendi
var. *luteotinctum* Flaksb.	Khankendi
var. *aeruginosum* Flaksb.	Khankendi
ssp. *asiaticum* Stol. proles *carabachicum* Vav.	Khankendi
var. *uniaeruginosum* Dorof.	Khankendi
ssp. *turgidoides* Must.	Khankendi, Shusha
var. *rubromuticum* Must.	Khankendi
var. *nigroalbomuticum* Must.	Khankendi
var. *nigrorubromuticum* Must.	Khankendi
var. *albospicatum* Must.	Shusha
var. *pseudoalbospicatum* Must.	Shusha
var. *rubrospicatum* Must.	Shusha
var. *pseudorubrospicatum* Must.	Shusha
var. *pseudonigroalbum* Must.	Lachin
var. *pseudonigrorubrum* Must.	Lachin
var. *nigrum* Must.	Aghdara

Continued table 1

Species	Location
●***T.durum* Desf.**	
gr. *leucurum* Al.	Aghdam, Jabrail, Fuzuli, Zangilan, Aghoglan, Khojavend, Khankendi
gr. *leucomelan* Al.	Aghdam, Fuzuli
f. *scabriaristatum* Must.	Aghdam
f. *transcaucasicum* Men.	Khankendi
var. *libicum* Körn.	Khojavend
var. *provinciale* Al.	Khojavend
var. *erythromelan* Körn.	Khojavend
var. *affine* Körn.	Aghdam
var. *horanoaffine* Jakubz.	Aghdam
var. *plinium* Körn.	Khojavend
var. *alexandrinum* Körn.	Khojavend
var. *murciense* Körn.	Khojavend
var. *reichenbachii* Körn.	Aghdam
gr. *hordeiforme* (Host.) Körn.	Aghdam, Jabrail, Zangilan, Fuzuli, Aghoglan, Khojavend, Aghdara, Khankendi, Shusha
f . *elongatum* Men.	Aghdam
f. *breviacutidentatum* Must.	Khojavend, Aghdara
f. *ekaterinovskense* Greb.	Aghoglan, Fuzuli
f. *rubellum* Must.	Aghdam
f. *oblongum* Must.	Aghdam
f. *brevidentatum* Men.	Fuzuli
var. *rubrospicatum* Stol.	Shusha
gr. *alboprovinciale* Flaksb.	Aghdam
f. *plenoalboprovinciale* Must.	Aghdam
var. *alboobscurum* Flaksb.	Aghdam
var. *valenciae* Körn.	Aghdam
gr. *melanopus* Al.	
var. *melanopus* Al.	Khojavend
f. *brevidentatum* Men.	Jabrayil
f. *elongatum* Men.	Aghdara, Shusha
f. *tristum* Must.	Aghdam
var. *apulicum* Körn.	Aghdam
gr. *niloticum* Körn.	
var. *niloticum* Körn.	Khojavend
f. *elongatum* Men.	Aghdam
var. *capitatoniloticum* Flaksb.	Aghoglan
gr. *coerulescens* Bayle.	Aghdam, Khojavend
f. *oblongum* Men.	Shusha
f. *elongatum* Men.	Aghdara
f. *cuspidentatum* Men.	Aghdam
var. *africanum* Körn.	Aghdam
var. *ramosoreichenbachii* Aliz.	Aghdara
var. *ramosoprovinciale* Aliz.	Aghdara
var. *ramosolencurum* (Gandil.) Aliz.	Aghdara
●***T.turgidum* L.**	
ssp. *mediterraneum* Vav.	
var. *melanatherum* Körn.	Aghdam
var. *nigrobarbatum* (Desv.) Körn.	Khankendi
var. *miscibile* Haciz.	Khankendi, Fuzuli
var. *dreischianum* Körn.	Fuzuli
var. *nachitschevanicum* Kulesch.	Aghdam
● T. persicum Vav. (*T.cartlicum* (Vav.) Nevski)	
var. *stramineum* Flaksb.	Aghdara
var. *rubiginosum* Zhuk.	Kalbajar, Lachin
var. *fuliginosum* Zhuk.	Aghdam
● *T. turanicum* Jakubz.	
var. *insigne* Perc.	Khojavend, Fuzuli

Continued table 1

Species	Location
var. *notabile* Perc.	
● ***T. polonicum* L.**	
ssp. *mediterraneum* Vav.	Khojavend, Fuzuli, Aghdam
var. *levissimum* Hall.	Fuzuli
var. *pseudolevissimum* Jakubz.	Fuzuli
●***T. spelta* L.**	
var. *pseudoalboarduin* Dorof.	Lachin
var. *flaksbergeri* Dorof.	Lachin
ssp. *vavilovi* (Jakubz.) Must	
var. *vaneum* Jakubz.	occurred in the farming fields
●***T. aestivum* L.**	
gr. *albidum* Al.	Fuzuli, Aghdam
gr. *lutescens* Al.	
f. *capitatum* Men.	Aghdam
var. *velutinum* Körn.	Aghdam, Fuzuli
var. *ramosolutescens* Must.	farming fields of mountains districts
gr. *alorubrum* Körn.	
f. *elongatum* Men.	Aghdam
var. *introitum* Vav.et Jakubz.(prol. *subrigidum* Vav.)	Fuzuli
gr. v*elutinum* (Schübl.) Körn.	Lachin, Khankendi, Aghdam, Khojavend, Aghoghlan
f. *pruinosum* Must.	Aghdara
var. *delfi* Körn.	Fuzuli
var. *pyrothrix* Al.	Aghdam, Zangilan
gr. *erythrospermum* Körn.	
f. *longidentatum* Men.	Aghdara
f. *longisculum* Must.	Aghdam
f. *glabriaristatum* Must.	Aghdara
f. *brevicrassispicatum* Must.	Fuzuli
var. *suberythrospermum* Vav.	Aghdam
gr. *nigriaristatum* Flaksb.	
f. *caduenum* Men.	Shusha
gr. *ferrugineum* Al.	
f. *tenuispicatum* Men.	Khojavend
f. *elongatum* Men.	Aghoglan
f. *oblongum* Must.	Aghdara
f. *densispicatum* Men.	Aghdam
f. *splendospicatum* Must.	Khojavend
f. *nigroferrugineum* Jakubz.	Fuzuli
f. *glaucospicatum* Must.	Jabrayil
var. *subferrugineum* Vav.	Aghdam, Fuzuli
var. *ferrugineum-compactoides* Kob.	Khojavend (Ningi viliage)
gr. *sardoum* Körn.	
f. *longidentatum* Men.	Aghdam, Aghoglan, Khankendi, Zangilan
f. *oblongum* Must.	Aghdam, Aghoglan, Khankendi, Zangilan
gr. *caesium* Al.	
f. *aristidentatum* Men.	Aghdara
f. *rigidum* Must.	Aghdara
f. *capitatum* Men.	Aghdara
var. *nigrocaesium* Dek.	Khankendi (Garov viliage)
var. *nigricans* How.	Aghdam, Zangilan
var. *bengalense* How.	Aghdam
var. *meridionale* Körn.	Zangilan
gr. *hostianum* Clem.	Fuzuli, Khankendi, Lachin
gr. *pseudehostianum* Flaksb.	Zangilan, Fuzuli
var. *pseudoturcicum* Vav.	Aghdam, Shusha, Aghdara
var. *turcicum Körn.*	Lachin
gr. *barbarosa* Al.	Aghdara, Khojavend, Aghdam, Fuzuli, Aghoglan
f. *oblongum* Must.	Aghdam
var. *kazvinicum* Vav.	Lachin

Continued table 1

Species	Location
var. *griseum* Vav. var. *rubromurinum* Flaksb.	Khankendi Aghdam
●***T.compactum* Host.** ssp. *armeno-turkestanicum* Vav. var. *echinodes* Körn. var. *erinaceum* (Dek.) Körn.	 Kalbajar Aghdam, Fuzuli, Khojavend
***Aegilops* L.**	
Ae. biuncialis Vis.	Aghdara, Aghdam, Asgeran, Khojaly, Khankendi, Aghoglan, Jabrayil, Fuzuli
Ae. triuncialis L.	Aghdara, Aghdam, Asgeran, Khojaly, Khankendi, Aghoglan, Jabrayil, Zangilan, Khojavend, Shusha, Lachin, Fuzuli
Ae. cylindrica Host.	Aghdara, Aghdam, Asgeran, Khojaly, Khankendi, Jabrayil, Zangilan, Aghoglan, Fuzuli, Lachin
Ae. umbellulata Zhuk.	Zangilan, Aghoglan, Khojavend
Ae. columnaris Zhuk.	Zangilan
Aegilops tauschii Coss. *(syn. Ae. squarossa* L.)	Aghoglan, Jabrayil, Zangilan, Khojavend, Khankendi, Shusha, Aghdam, Lachin, Fuzuli, Aghdara
Ae.comosa Sibth.	Fuzuli
Ae. neglecta Req. ex Bertol. (=*Ae. triaristata* Willd.)	Aghoglan, Zangilan, Khojavend, Shusha, Khankendi, Agh-dam, Lachin, Fuzuli
***Hordeum* L.**	
H. bulbosum L.	Lesser Caucasus
H. glaucum Steud.	Lesser Caucasus
H. leporinum Link.	Lesser Caucasus
H. spontaneum C.Koch	Lesser Caucasus
H.murinum L.	Aghdam
H. lagunculiforme Bacht.	Aghoglan
H. violaceum Boiss.et Huet	Lesser Caucasus
***Secale* L.**	
S. caldicum Fed.	Lesser Caucasus
●*S. cereale* subsp. *segetale*	Shusha
***Elytrigia* Desv.**	
E. caespitosa (C.Koch)Nevski	South and Central Lesser Caucasus
E. elongata (Host) Nevski	Lesser Caucasus
E. elongatiformis (Drob.) Nevski	Lesser Caucasus
E. intermedia (Host) Nevski	Central Lesser Caucasus
E. pulcherrima (Grossh.) Nevski	Central Lesser Caucasus
E. repens (L.)Nevski	Lesser Caucasus
E. trichofora (Link) Nevski	Lesser Caucasus
E. turcica P.E.McGuire	Lesser Caucasus
Elymus L.	
E. transhyrcanus (Nevski) Tzvel. (=*Agropyron leptourum* (Nevski) Grossh.)	Altintaxta pass of Mount Great Kirs (Lachin-Khojavend road), Mount Girkhgiz (Lachin, Kalbajar, Khojali)
E. caucasicus (C.Koch) Tzvel. (=*Agropyron caucasicum* (C.Koch) Grossh.)	Northern Lesser Caucasus
E. caninus (L.) L. (=*Agropyron caninum* (L.) Beauv.)	Lesser Caucasus
***Agropyron* Gaertn.**	
A. pectinatum (Bieb.) Beauv. (=*A. cristatum* auct. Cauc.)	Lesser Caucasus
***Eremopyrum* (Ledeb.) Jaub.et Spach**	
E. hirsitum (Bertol.) Nevski	Lesser Caucasus
E. orientale (L.) Jaub.et Spach	Lesser Caucasus

Continued table 1

Species	Location
***Hordelymus* (Jess.) Harz**	
H. europaeus (L.) Harz (=*Hordeum europaeum* (L.) All.)	Western Lesser Caucasus
***Taeniatherum* Nevski**	
T. crinitum (Schreb.) Nevski (=*Hordeum crinitum*) (Schreb.) Desf.)	Lesser Caucasus
● – cultivated species	

Khorasan wheat *T. turanicum* Jakubz. (=*T. turgidum* ssp. *Turanicum* (Jakubz.) Mac Key) found in Azerbaijan included 11 botanical varieties, of which 2 occurred in Karabakh. The total number of botanical varieties for this species is 13 and Azerbaijan has the largest amount of botanical varieties in the South Caucasus (Mustafayev, 1973). *T. turanicum* and *T. polonicum* were characterized by the significantly highest 1000-grain weight in both rainfed and irrigated conditions, which suggests that these wheat species might have promising alleles to be transferred into durum wheat to increase grain yield (Akman H., 2021).

Spelt wheat (*T. spelta* L.) belongs to the hexaploid group of cultivated *Triticum* wheat with fragile spikes and hulled kernels. This ancient cereal was created 7,000 years ago, most likely by the spontaneous crossing of wild grass species. By the mid-twentieth century, spelt wheat had an important role in the diet of humans, afterwards, it has been gradually replaced by yielding soft wheat (*T. aestivum* L.) (Ugrenovich et al, 2018). Spelt wheat is classified into 2 subspecies: *spelta* and *kuckuckianum* Gökg. The 17 botanical varieties of this species were found in Azerbaijan, if not to consider 2 varieties, which later included in species *T. vavilovi* Jakubz. (=*T. aestivum* ssp. *Vavilovii* (Thum.) Jakubz.). 2 botanical varieties of *T. spelta* and 1 (var. *vaneum* Jakubz.) from *T. vavilovi* were found in Karabakh. Vavilov suggested the South Caucasus as an origin for spelt wheat based on occurring here 2 spelt species totally with 50 botanical varieties (Dorofeev, 1972).

Being a young species the hexaploid wheat species T. *aestivum* L. is presented in Azerbaijan by 2 subspecies: *iranoasiaticum* Flaksb. and *indoeuropaeum* Vav. with a total of 65 botanical varieties, of which 15 were recorded for Karabakh. The most distributed botanical varieties in Azerbaijan were 4: *erythrospermum*, *ferrugineum*, *barbarossa* and *lutescens* (Мустафаев, 1973) (see Table 1). The 6 morpho-ecological groups of T. *aestivum* offered by Vavilov (1964) were: nachichevani, absheron-mughani, Armenian xerophytic, winter mountain Caucasian, spring mountain Caucasian and Azerbaijan-Dagestani foothills. Jakubciner (1957) defined also 6 ecological groups: Caucasian-subtropical, mountain Caucasian steppe, mountain Caucasian forest, mountain Caucasian forest-steppe, Transcaucasian lowland foothills, and Transcaucasian alpine. Dekaprelevich (1957) identified 11 ecotypes in his work "Wheat in USSR" (Dorofeev, 1972). Mustafayev (1973) included wheat of Azerbaijan from this species into 16 groups, of which 12 occurred among cultivated wheat species in Karabakh. He emphasized that among the groups of T. *aestivum*, the accessions from the gr. *barbarosa* Al. and gr. *pseudobarbarosa* Vav. were more susceptible to the leaf rust, from gr. *lutescens* Al., gr. *milturum* Al. and gr. *caesium* Al. – to the stripe rust, but more resistant to the first disease were accessions from gr. *albidum* Al., gr. *hostianum* Clem., as well as also from gr. *lutescens* Al., and resistant to the second disease – gr. *graecum* Körn., gr. *erythroleucon Körn*., gr. *hostianum* Clem., gr. *turcicum* Körn., gr. *barbarosa* Al. and gr. *pseudobarbarosa* Vav.

The wheat species *T. compactum* Host. (=*Triticum aestivum* ssp. *compactum* (Host.) Mac Key) were presented in the Karabakh region by 1 subspecies and 2 botanical varieties (Мустафаев, 1973) (see also Table 1).

The most complicated botanical diversity of wild wheat species and their spontaneous hybrids in the South Caucasus (Transcaucasia), including Azerbaijan, were observed in the foothill areas up to 600-800 m above sea level (Dorofeev, 1972).

***Aegilops* L.** The age for herbarium specimen of goat grass from Azerbaijan dates back to 1886 (van Slageren, 1994). Zhukovsky (1928) described five species of goat grasses for Azerbaijan: *Ae.*

biuncialis, *Ae. neglecta* (as *Ae. triaristata* Willd.), *Ae. triuncialis* L., *Ae. tauschii* (as *Ae. squarrosa* auct. non L.), and *Ae. cylindrica*. Eig (1929a) added *Ae. kotschyi* to this list, while Grossheim (1939) located seven species by adding another two species—*Ae. umbellulata* Zhuk. and *Ae. columnaris* (see also Dorofeev and Migushova, 1973). For Azerbaijan, Karyagin (1950) presented the above-mentioned seven species except for *Ae. columnaris*. Mustafayev (1961) located 13 species for the country: *Ae. ovata* L. [=*Ae. geniculata* Roth], *Ae. triaristata* [=*Ae. neglecta*], *Ae. biuncialis*, *Ae. triuncialis*, *Ae. crassa* Boiss., *Ae. cylindrica*, *Ae. comosa* Sibth. et Sm., *Ae. columnaris*, *Ae. squarrosa* L., *Ae. caudata* L., *Ae. ventricosa* Tausch, *Ae. umbellulata*and *Ae. uniaristata* Vis. (misidentifications regarding 4 species (*Ae. comosa* Sibth. et Sm., *Ae. caudata* L., *Ae. ventricosa* Tausch, and *Ae. ovata* L.) caused the number to be higher than has been proven since). Despite the historic presence of herbarium specimens of *Ae. juvenalis* (Thell.) Eig. and *Ae. peregrina* (Hack. in J.Fraser) Maire et Weiller from Azerbaijan (van Slageren, 1994) they have not been relocated in at least 50 years. (Eldarov et al., 2015).

The latest expeditions for the studies on botanical composition for goat grasses of Azerbaijan related with the names of Mustafayev (1961), as well as Dorofeev and Migushova (1966, 1969, 1973). In his expedition to the Karabakh, Мустафаев (1961) indicated the foothills and mountainous areas of Aghdara, Aghdam, Asgeran, Khojaly, and Khankendi regions of Karabakh as the places, that are especially distinguished for the diversity of the genus *Aegilops* L. The species *Ae. triuncialis* L. and *Ae.biuncialis* Vis. were the most common for those areas, *Ae.cylindrica* Host. relatively less, and very rare - *Ae.umbellulata* Zhuk., the latter is generally considered as a rare species for the territory of Azerbaijan (outside of Karbakh this species was found near the Girdman River in Ismayilli and Gilanchay River in Nakhichevan). In the humid areas of the mentioned regions, mainly *Ae. squarossa* L.(=*Aegilops tauschii* Coss.) and *Ae. cylindrica* Host. species have been observed to be more common. The *Ae.ovata* L. species was recorded for the first time for the territory of Karabakh on the mountain slopes at 900 and 1100 m above sea level in the Aghoglan (historical name for Hadrut) region, near Malibeyli, Girmizi, Sarishkend, and other viliages. It was found on the right side of the Gargarchay, which is along with Karkijahan, Khalfali and Zarisli rivers flowing from the eastern part of the Garabag range, near the settlement called Khanbagi on the Shusha-Khankendi road. However, later these accessions' names were determined as misidentification and they were identified as *Ae.umbellulata* by V.F.Dorofeev and E.F.Migushova (1971), who also made the same mistakes in their previous works, as well as the other scientists – I.Shmalgauzen (1897), V.I.Lipskiy (1899), A.V.Fomin and Y.Voronov (1909). The main reason confusing researchers was as noticed by Grossheim (1939) "the inconsistency between the diagnosis given by Zhykovsky for this species and the collected samples of it from the territory of Azerbaijan" (Dorofeev and Migushova, 1971). Considering the spikes of *Ae.umbellulata* accessions collected from Azerbaijan as the most large-sized compared with the samples from Turkey and Iran the latter authors suggested them as the new taxon: *Ae. umbellulata* subsp. *transcaucasica* Dorof. et Migusch (=*Ae. umbellulata* Zhuk. f. *girdmanica* Mustafayev and Aminov). The early collection of this species in Karabakh had been done by M.F.Sakhokia (1931) near the Aghdam and Gurvich Ts.E. (1936) near the village Shushakend (Гроссгейм, 1939; Dorofeev and Migushova, 1971).

Along with the fields of wild species, a large number of natural hybrids between *Aegilops* species and durum, as well as with bread wheat, were found in the Fuzuli region of Karabakh, on the Fuzuli-Jabrail road, and in the Jabrayil region. In 1961-1970, the employees of the All-Russian Institute of Plant Breeding conducted expeditions in the Karabakh region of Azerbaijan by collecting the 5 goat grass species (*Ae. squarossa* L., *Ae. cylindrica* Host., *Ae. triuncialis* L., *Ae. biuncialis* Vis. And *Ae. triaristata* Willd.) in Aghoglan at 800 m above sea level, 4 species (*Ae. squarossa* L., *Ae. cylindrica* Host., *Ae. triuncialis* L., *Ae. biuncialis* Vis.) in the Jabrayil region - 250 m, 4 species (*Ae.squarossa* L., *Ae.cylindrica* Host., *Ae. triuncialis* L., and *Ae. triaristata* Willd.) in Zangilan - 610 m, 3 species (*Ae. squarossa* L., *Ae. triuncialis* L. and *Ae. Triaristata* Willd.) in Khojavend region - 800 m, 3 species (*Ae. squarossa* L. , *Ae. triuncialis* L. and *Ae. triaristata* Willd.) in Khankendi region - 1120 m and 3 species (*Ae.squarossa* L.,

Ae.triuncialis L. and *Ae.triaristata* Willd.) at an altitude of 1000 m above sea level in Shusha region (see Table 1).

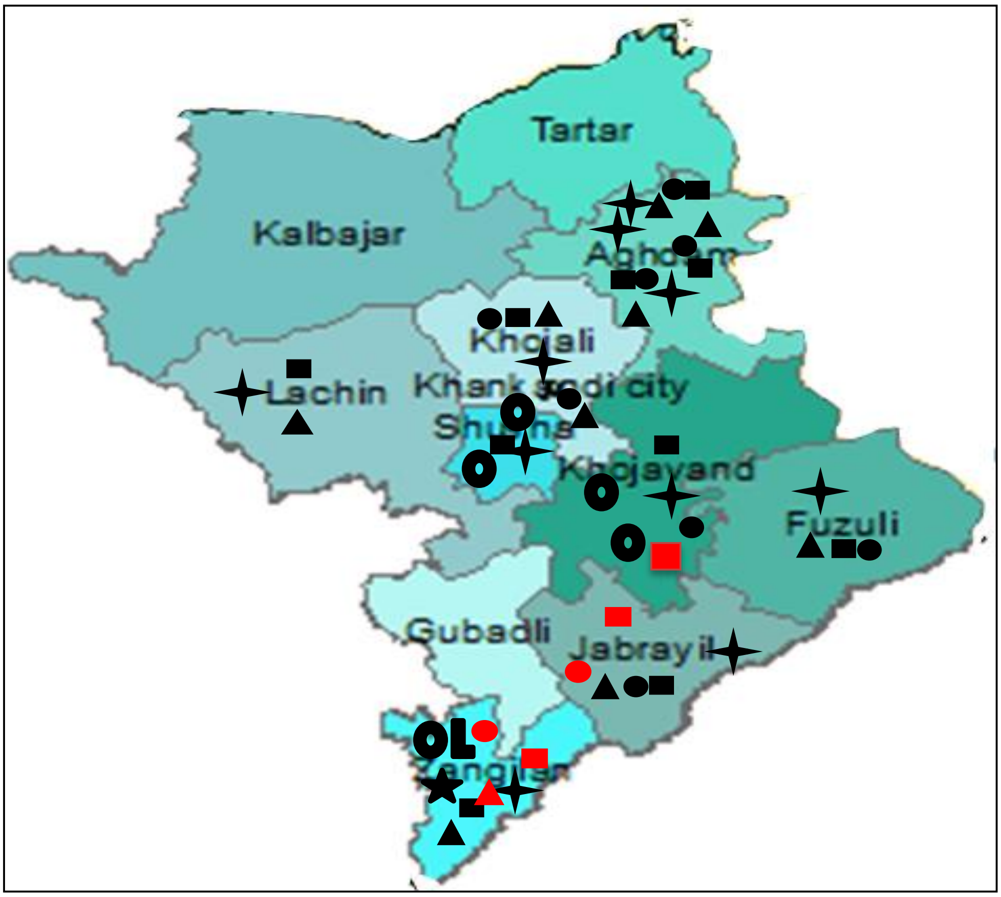
Hence, if Aghoglan could be considered as the location for the most diversity of *Aegilops* L., then Zangilan is the most valuable location for both genera - *Aegilops* L. and *Triticum* L. in Karabakh (see Fig. 2.). Therefore, special attention should be given to both locations in the planned monitoring works at the liberated areas of the Karabakh region.

***Secale* L.** is a small but economically important taxon, which includes wild relatives and landraces, comprising cultivated rye, containing annual, perennial, self-incompatible or self-compatible, cultivated, weedy, and wild taxa. Classification of the genus *Secale* is inconsistent and comprises 3–4 to 8 species from the phylogenetic studies in the last ten years (Maraci et al., 2018; Daskalova and Spetsov, 2020). According to Asgerov (2016), this genus is represented in Azerbaijan by 7 species, of which only the species *S. chaldicum* Fed. (syn. *S. strictum* (C.Pesl) C.Pesl.; *S.montanum* Guss.), commonly known as mountain rye, was found in Karabakh. Mountain rye is a cool temperature, perennial, known to be frost - and drought resistant and yet the intergeneric amphiploid with wheat was found to be tolerant to waterlogging (Tang et al., 2011). Its native range extends from the Sierra Nevada mountains in southern Spain in the west to Iran and the Caspian Sea in the east. Mountain rye shows great potential as a perennial forage crop in semi-arid and mountain regions (Rossi et al., 2020). There is a general agreement on *S. strictum* being the ancestral form, from which the divergence of *S. silvester* was proposed. *S. strictum* subsp. *africanum* is considered to have diverged from *S. strictum* during the early Pleistocene and evolved independently. *S. cereale* and *S. vavilovi*, on the other hand, are considered to be evolutionarily the youngest species (Maraci et al., 2018).

During his expedition (19.06.1960-25.06.1960), Mustafayev was also recorded distribution of *S. cereale* subsp. *segetale* in plant community with wild barley and goat grasses in the mountainous areas of Shusha at an altitude of 700-910 m above sea level.

***Hordeum* L.** are grasses, most conspicuously characterized by their inflorescence that is a spike instead of the panicle that occurs in most other grasses. This genus apart from cultivated barley (*Hordeum vulgare* subsp. *vulgare*) comprises more than 30 wild grass species distributed in temperate and arid regions of the world. The wild progenitor of the cereal is *H. vulgare* subsp. *spontaneum* from Southwest Asia. Together with bulbous barley (*Hordeum bulbosum*), the closest relative of the crop, and wall barley (*Hordeum murinum*) these species are grouped within subgenus *Hordeum*, while all other species belong to subgenus *Hordeastrum* (Blatner, 2018). There are 12 species of *Hordeum* in Azerbaijan, of which 2 are cultivated (*H. vulgare* and *H. distichum*), the area of Lesser Caucasus represented by 5 species (Əsgərov, 2016). The last data about the distribution of *Hordeum* species in the Karabakh region of Azerbaijan was given by Mustafayev (1961) and Kobilyanskiy (1966). *H. spontaneum* C.Koch. and *H. leporinum* Link. were recorded for Lachin, the latter also for Aghdam (570 m a.s.l.), *H. spontaneum*, *H. bulbosum* L. and *H. leporinum* – for Khojavend, *H. spontaneum* and *H. lagunculiforme* Bacht. for Aghoglan (Hadrut), *H. spontaneum*, and *H. bulbosum* – for Shusha, subsequently. *H. spontaneum* C.Koch in Fuzuli (500 m a.s.l.), on the Khojavend - Fuzuli road and wild barley varieties such as *H. bulbosum* L. have been reported to be widespread. *H. murinum L.* was found in Aghdam at an altitude of 500 m above sea level.

Bakhteev (1960) identified the bottle-shaped wild barley form, *H. lagunculiforme* Bacht., to be the ancestor of all cultivated *H. vulgare* forms. *H. vulgare* subsp. *spontaneum* (=*H. spontaneum* C.Koch.). *H. vulgare* subsp. *spontaneum*, belongs to the primary gene pool, a valuable source of genes for stress tolerance and adaptation to marginal environments and low-input farming systems, and a source of novel genes for disease and insect resistance. *Hordeum bulbosum* L. is the single species in the secondary gene pool, and has been used as a source of resistance to a number of diseases, such as powdery mildew, leaf rust, and scald, and as a source of resistance to barley mosaic virus. Crosses with cultivated barley mostly result in *bulbosum* chromosome elimination and production of *vulgare* haploids.



● – *Ae. biuncialis* Vis.; ■ – *Ae. triuncialis* L.; ▲ – *Ae. cylindrica* Host.; ▙ – *Ae. umbellulata* Zhuk.;
★ – *Ae. columnaris* Zhuk.; **O** – *Ae tauschii* Coss (=*Ae. squarossa* L.); ✦ – *Ae. neglecta* Req. ex Bertol. (=*Ae. triaristata* Willd.)
▬ – *T. boeoticum Boiss.* (=*T. boeoticum* Boiss. ssp. *aegilopoides* Bayle. var. *pseudoalbum*);
⬬ – *T. boeoticum* Boiss. ssp. *thaoudar* (Reut) Flaksb.;
▲ – *T.urartu* Thum. ex Gandilyan (=*T. boeoticum* Boiss. ssp. *urartu* Thu

Fig. 2. Distribution of wild cereals from genera *Aegilops* L. and *Triticum* L. in the Karabakh region of Azerbaijan

This phenomenon has been widely exploited in the production of doubled haploids used as mapping populations for genetic studies and for shortening the breeding cycle (Kang, Priyadarshan, 2007). *Hordeum murinum* subsp. *leporinum* L. (hare barley) is an annual grass species dominant in Mediterranean savannah-like ecosystems, with great relevance in pasture dynamics due to its fast growth and high palatability for livestock (Chano et al, 2021).

***Elytrigia* Desv.** Both genera - *Elytrigia* Desv. and *Elymus* L. were excluded from the tribe *Triticeae* in some taxonomical treatments (Цвелев, 2019). The genus *Elytrigia* Desv. is sharing a common genome originated from genus *Pseudoroegneria*, which is included in the genus *Elytrigia* Desv. according to the classification followed in this paper (Əsgərov, 2016) (Table 1).

Elytrigia Desv. is widely distributed throughout the world and is represented with species of various levels of ploidy including diploids, tetraploids, hexaploids, octaploids, and decaploids. *E. intermedia* and *E. repens* were grouped into three distinct levels of ploidy including diploids, tetraploids, and hexaploids. For *E. elongata*, *E. pontica*, and *E. caespitosa*, it was found that two ploidy levels were presented, and only one ploidy level was

in those of *E. hybrid, E. pycnantha, E. pungens, E. juncea*, and *E. alatavica* (Mao et al., 2010). The species of the genus are widely used in agriculture (*E. repens, E. elongata*, *E. intermedia*) as fodder herbs and erosion control (*E. repens*, *E. stipifolia* (Czern. ex Nevski) Nevski), as the herbs for medicine (*E. repens*). According to recent data, the genus includes about 50 species (Oliynyk and Gubar, 2019), in Azerbaijan, the 13 species is distributed, of which 8 species were found also in the Lesser Caucasus (Əsgərov, 2016) (see Table 1), i.e. possibly in the Karabakh region.

***Elymus* L.** *Elymus* L. (wild rye) is a large genus that contains about 150 species distributed across a wide range of ecological sites across temperate and subtropical regions of the world. *Elymus* L. includes many economically important forage grasses as well as species that possess useful genes for disease resistance, stress tolerance and adaptation, which can potentially be transferred to cereal crops through gene introgression (Qi et al., 2013). Several *Elymus* species have been developed as forage cultivars (e.g., blue wildrye (*E. glaucus* Buckley), thickspike wheatgrass (*E. lanceolatus* Scrib. & J.G. S.M), Canada wild rye (*E. canadensis* L.), slender wheatgrass (*E. trachycaulus* Link), Snake River wheatgrass (*E. wawawaiensis* J. Carlson & Buckley), and Virginia wildrye (*E. virginicus* L.). To date, multiple *Elymus* species have been hybridized in a variety of pre-breeding initiatives (for example, there are at least 17 *Elymus*-wheat hybrids) (Frawley et al., 2020).

There are at least 4 species from this genus in Azerbaijan, of which 1 species - *Elymus transhyrcanus* is distributed only in the Karabakh region of Azerbaijan, the status of distribution for another 2 species – *Elymus caninus* (L.) L. (syn. *Agropyron caninum* (L.) Beauv.) and *Elymus caucasicus* (C.Koch) Tzvel. (syn. *Agropyron caucasicus* (C.Koch) Gross.) should be checked as the Lesser Caucasus was among of their site of growing in Azerbaijan.

***Agropyron* Gaertn.** is an important wild relative of wheat that has the genome of P: diploid, PP, $2n=2x=14$; tetraploid, PPPP, $2n=4x=28$; and hexaploid, PPPPPP, $2n=6x=42$. Most *Agropyron* species are excellent sources of forage and habitat for livestock and wildlife, and they are also valued for weed control, habitat use, soil stabilization, and watershed management. *Agropyron* species possess a lot of useful characteristics, such as tolerance to drought and cold, resistance to diseases, and high yield traits. It is a quality forage for grassland improvement and a valuable genetic resource for wheat (Che et al., 2018). This genus is represented in Azerbaijan by 4 species, of which the most distributed *A. pectinatum* is the only one that was found in Karabakh. *A. pectinatum* is a warm-loving and light-loving xerophyte, valuable perennial forage plant (Luo et al., 2021).

***Eremopyrum* (Ledeb.) Jaub. et Spach** is a well-circumscribed genus with an annual habit and oblong to orbicular fragile spike-like inflorescence that is used in wheat improvement. To date, 18 species and many infraspecific taxa have been described, but the number of species accepted varies from four to nine. The Plant List (2013) currently recognizes four species and 44 synonyms (Romero et al., 2018). There are at least 5 species from this genus in Azerbaijan, of which for the 2 species – *E. hirsitum* (Bertol.) Nevski and *E. orientale* (L.) Jaub.et Shpach - the Lesser Caucasus was shown among of the places of distribution. Therefore, the Karabakh area should be checked to determine the status of these species.

***Hordelymus* (Jess.) Harz is** the genus that comprises only a single allotetraploid species - *H. europaeus* (L.) Jess. ex Harz [= *Elymus europaeus* L.] (2n=4x=28) (wood barley) with two genomes: TH (T from *Taeniatherum*, H from *Hordeum* according to Löve 1984) or TN (T from *Taeniatherum*, N from *Psathyrostachys* according to Bothmer et al., 1994). Analyses of sequence data from plastid genes and single-copy nuclear genes showed close phylogenetic relationships of wood barley with such genera as *Psathyrostachys*, *Pseudoroegneria*, and *Henrardia*. All these findings indicated its importance in the understanding the evolution and differentiation within the tribe *Triticeae*. For these reasons, *Hordelymus* was subjected to extensive ecological, floristic, and phylogenetic studies (Mizianty et al., 2006; Klimko et al., 2015). The area of the Lesser Caucasus among others in Azerbaijan shown as a site for the growing of wood barley.

***Taeniatherum* Nevski** (genome TaTa, 2n=2x=14) contains three diploid species, *Ta. caput-medusae*, *Ta. crinitum*, and *Ta. asperum*. The subspecies *caput-medusae* is a native species to

Europe and is mostly restricted to Spain, Portugal, southern France, Algeria, and Morocco. Subspecies *crinitum* is found from Greece and the Balkans east into Asia, and the range of subspecies *asperum* completely overlaps the other two subspecies (Kostivkovsky and Young, 2000). These species are the annual herbs represented by only one species - *Ta. crinitum* (Shreb.) Nevsky (syn. *Hordeum crinitum* (Shreb.) Desf.) in Azerbaijan and its Lesser Caucasus area is among its distribution places.

It should be noted that the all information presented above regarding the Karabakh region mainly reflects the available historical data. Starting from occupation since to date there was no large-scale monitoring of wild cereal species in the Garabakh region of Azerbaijan. The main reason for this was the long occupation period of these areas – 30 years. The importance of diversity protection of wild cereals in the Karabakh region is based also on their value to be served as donors of the resistance to biotic and abiotic stresses for the cultivated wheat. For over the past 30 years, scientists did not have access to the areas to conduct their research works, including investigation of plant composition and diversity of the region. Thus, one of the main goals of correct restoration of the region is to carry out studies on plant composition of Karabakh to obtain relatively new results compared with historical data, as the successful restoration requires the identification of species status and diversity that are adapted to the ecological conditions of the restoration sites.

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Azərbaycanin Qarabağ bölgəsində *Triticeae* genetik ehtiyatlarinin müxtəlifliyi

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Məqalədə buğda tribası *Triticeae* Dum. taksonu daxilində Azərbaycanın Qarabağ bölgəsi üçün işğaldan əvvəl təsvir edilən növlərin kolleksiyalarına dair tarixi məlumat verilir. Kiçik Qafqazın çox hissəsini əhatə edən, yarı səhra və quru çöl iqlimi olan Azərbaycanın Qarabağ bölgəsi müxtəlif taxıl bitkiləri üçün əlverişli şəraitə malikdir. Azərbaycan ərazisində *Triticeae* tribasından 14 cinsə aid olan dənli bitkilər yayılmışdırlar ki, onlardan tarixən ən azı 10 cinsə aid növlər həmçinin Qarabağ üçün də təsvir edilmişdir. Məqalədə müxtəlif elmi mənbələrə əsaslanaraq təqdim edilən məlumatlar Qarabağ bölgəsinin işğaldan azad edilmiş və minalardan təmizlənmiş ərazilərin *Triticeae* tribasına aid olan növlərin statusunu və yayılmasını müntəzəm monitorinqi üçün planlaşdırılmış tədqiqatlar üçün faydalı olacaqdır.

Açar sözlər: *Azərbaycanın Qarabağ bölgəsi, Triticeae Dum. tribası, Aegilops* L., *Triticum* L., *Hordeum* L., *Secale* L., *Agropyron* L., *yabanı taxıllar*

Разнообразие генетических ресурсов *Triticeae* в Карабахском регионе Азербайджана

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В данной статье дается исторический обзор коллекций видов из трибы *Triticeae* Dum., описанных для Карабахского региона Азербайджана до периода его оккупации. Покрывая большую часть Малого Кавказа, обладая полупустынным и сухим степным климатом, Карабахский регион Азербайджана имеет благоприятные условия для создания разнообразия злаковых трав. В Азербайджане распространены 14 родов злаковых растений, относящихся к трибе *Triticeae,* из которых исторически самое меньшее 10 родов были описаны также для Карабаха. Представленные в статье данные основываются на различных литературных источниках и будут полезны для проведения постоянного мониторинга статуса и распространения видов из трибы *Triticeae* на освобожденных и разминированых территориях.

Ключевые слова: *Карабахский регион Азербайджана, триба Triticeae Dum., Aegilops* L., *Triticum* L., *Hordeum* L., *Secale* L., *Agropyron* L., *дикорастущие злаки*

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Preparation of soil maps and ecological assessment maps of soils of the territories of Azerbaijan liberated from occupation

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The article describes the qualities of common soils in the Karabakh region. The state of soils before and after the occupation has been comparatively studied. Agroecological features and proposals for the further use of the region's soils are given. The agroecological features of soils were studied for more efficient use in the future and proposals were indicated. Agroecological zoning and environmental assessment was carried out on the basis of geographic information systems. Also, an altitude model of the Lesser Caucasus, soil maps, appraisal and environmental assessment have been prepared. In addition to general maps, these maps are compiled for each area.

Keywords: *Karabakh region, ecological assessment, agroecological features, agriculture, soil maps, GİS*

INTRODUCTION

The glorious and victorious Azerbaijani Army under the leadership of the President of the Republic of Azerbaijan, Supreme Commander-in-Chief Ilham Aliyev liberated our lands, which had been occupied for 28 years, during the Second Patriotic War, which lasted 44 days.

The liberated lands of Karabakh in the price cadastral zoning of Azerbaijan belonged to Mil-Karabakh, Arazboyu, Lachin-Gubadli, Daghlig Karabakh valuable (cadastral) regions and the total area is 12.22 thousand square kilometers (table 2). The Karabakh region of our country covers most of the Lesser Caucasus region (81.5%), which is one of the 5 physical-geographical regions. The Lesser Caucasus physical-geographical region, in turn, is divided into 4 agroecological regions.

In all times and in all countries, land is the first blessing. Mankind's entire existence has been established on earth. Land protection, conservation and increasing fertility is one of the most important tasks in low-land countries such as Azerbaijan (Mammadov, 2002; 2003).

MATERIALS AND METHODS

Guidelines for the preparation of interactive electronic soil maps and maps of ecological assessment of soils at a scale of 1: 100000 (Mammadov et al., 2020) were mainly used in the writing of the article.

The results of large-scale soil studies carried out by other researchers show that in the mountainous part of the Karabakh region, primitive mountain-meadow, mountain-meadow soddy, mountain-forest meadow, mountain-meadow dark, mountain-meadow black, mountain-forest brown typical, mountain-forest brown carbonate, mountain-forest brown typical, mountain-meadow steppe, mountain-forest brown cultivated, gray-brown mountain dark, mountain-forest brown leached, mountain-forest brown steppe, mountain-chestnut dark soils, and in the plain part the following types and subtypes were found: chestnut ordinary, chestnut long-irrigated, meadow-chestnut, gray, dark gray, gray typical, gray irrigated, gray meadow-brown, floodplain meadow (alluvial meadow), chestnut dark soils.

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RESULTS AND DISCUSSION

Large-scale soil surveys were conducted in the Lesser Caucasus, as well as in the territories of our liberated regions from the 1940s to the 1990s, and soil types, subtypes, genera, species diversity were identified. Soil maps and soil quality maps have been compiled for each farm and district. In conducting soil researches M.E.Salayev (1966), M.E.Salayev, A.K.Zeynalov, E.F.Sharifov (1965), M.P.Babayev (1967), Sh.G.Hasanov (1965, 1978), E.F.Sharifov (1984), A.O.Suleymanov (1986) and G.Sh.Mammadov (2002, 2003) are great. Agroecological zoning of Azerbaijan, including the lands liberated from occupation, ecological assessment of lands on the basis of GIS was carried out (Salayev et. al., 1965; 1966; Babayev, 1967; Hasanov, 1978; Sharifov, 1984; Suleymanov, 1986) (Fig. 2, Fig. 3, Fig. 4).

Employees of the Department of Agroecology and Soil Valuation of the Institute of Soil Science and Agrochemistry of the National Academy of Sciences of Azerbaijan under the leadership of Academician G.Sh.Mammadov, a map of soils and ecological assessment of soils was compiled for Kalbajar, Lachin, Shusha, Khojaly, Khojavend, Gubadli, Zangilan, Jabrail, Fizuli and Aghdam districts (figure 1) (Ministry of Defense of the Republic of Azerbaijan, 2020; Mammadov et al., 2021) (Table 1).

Relief (earth's plasticity) played an important role in the formation of soils in the liberated territories. Under the influence of the basins of the Bargushad, Hakari, Tartar, Araz and other rivers, and the mountain ranges of the Lesser Caucasus, various mosaic soils were formed in these areas. Soils are formed in 0-4000 meter horizons from dry subtropics to alpine and subalpine belts (Mammadov et al., 2016; 2020a; 2020b).

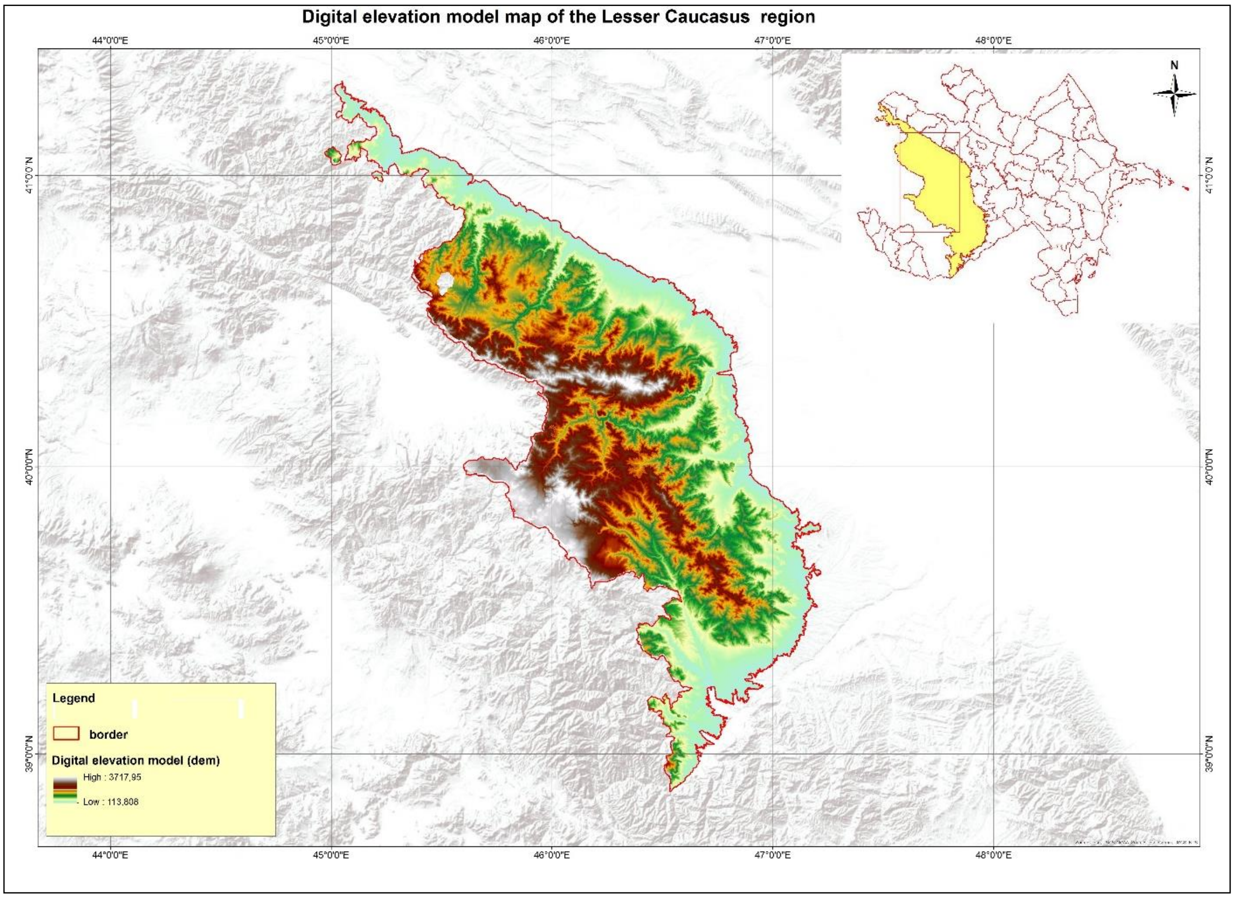


Fig. 1. Digital elevation model of the Lesser Caucasus region

Table 1. Types and subtypes of soils in the liberated territories and their main bonitet scale

Soil types and subtypes	Bonitet scale of soils – Districts										
	Aghdam	Aghdara	Jabrail	Fizuli	Khojavend	Khojaly	Gubadli	Zangilan	Kalbajar	Lachin	Shusha
Mountain-forest brown leached	100	94			100	93		99	88	93	96
Mountain-forest brown steppe	82		78								
Mountain gray-brown ordinary	75	75									
Mountain chestnut dark	77			81		72					
Ordinary chestnut	95	90	71	100	95						
Chestnut long-irrigated	92		86	86			90	90			
Meadow chestnut	80	63	92	70	67	62					61
Gray typical	78			82							
Gray irrigated	79			83							
Gray meadow	81										
Floodplain meadow (alluvial meadow)	75	70	70	79	75	70	74	74	66	65	72
Mountain meadow primitive		20							20	20	
Mountain meadow soddy		100							93	91	
Mountain forest meadow		92							91		
Mountain forest brown typical		98				96			92		
Mountain gray-brown light		50					45			45	
Mountain forest brown typical			94		100	94	100	100	89	94	98
Mountain forest brown cultivated			100			100					
Mountain gray-brown dark			86	86	86		84	81	77	77	75
Mountain gray-brown ordinary			78	78	75			74			
Chestnut dark			84				99	99			
Mountain forest steppe					86	80				80	96
Mountain forest brown carbonate						97					100
Mountain-forest brown steppe						75					
Mountain meadow dark									100		
Mountain meadow black									95		
Mountain-forest brown loess-like										89	
Mountain-forest black										100	



Pre-occupation landscape



View of arable lands during the occupation

Fig. 2. Photos released by the Ministry of Defense of the Republic of Azerbaijan

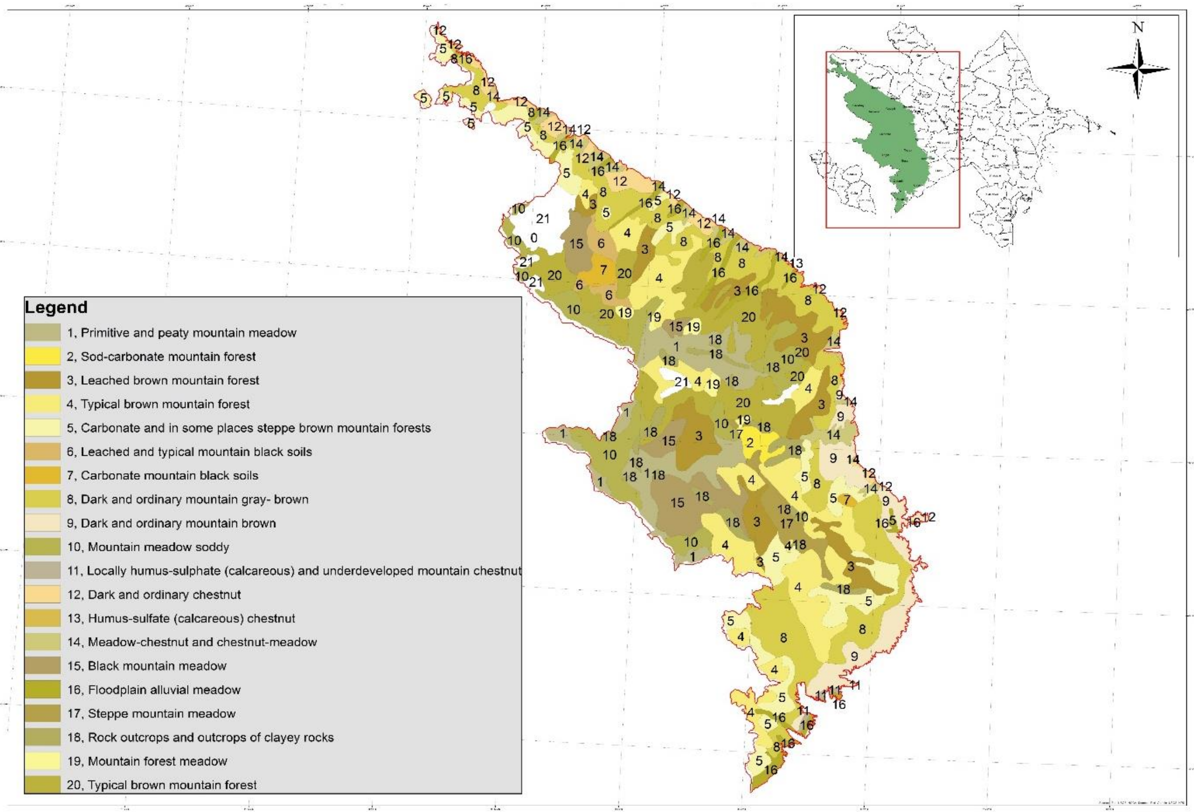


Fig. 3. Solil map of the Lesser Caucasus physical-geographical region

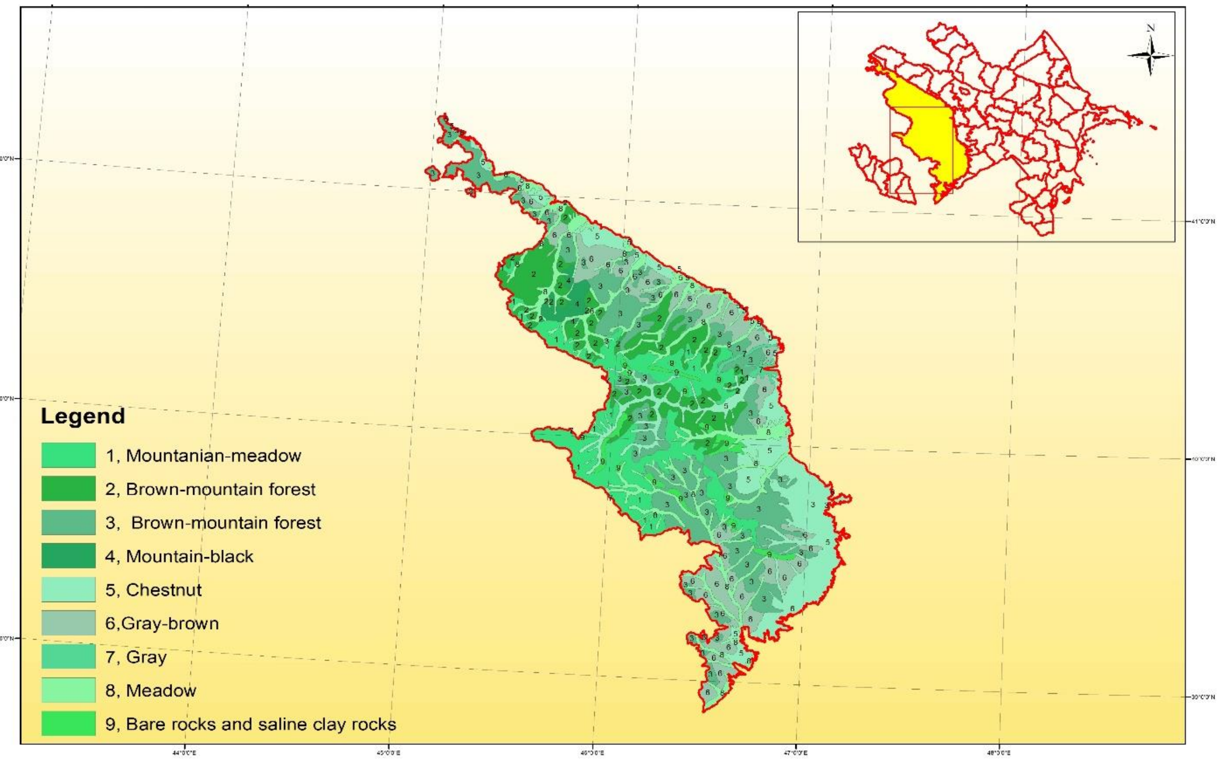


Fig. 4. Solil map of ecological assessment of the Lesser Caucasus physical-geographical region

Table 2. Distribution of liberated lands by natural and economic areas

№	Districts	Total area, ha	Including					
			arable land	perennial plantings	hayfields	pastures	backyards	other lands
1	Jabrail	104.497	20.501	7.243	24	23.154	789	52.776
2	Fizuli	67.649	23.428	10.376	444	25.541	1.059	6.801
3	Kalbajar	198.972	6.327	10	7.571	75.600	753	108.711
4	Gubadli	78.812	14.956	850	631	17.192	454	45.729
5	Lachin	182.603	14.167	245	4.682	69.319	720	93.970
6	Zangilan	72.550	7.801	2.667	607	22.873	412	38.590
7	Gazakh	7.663	1.575	-	-	1.947	168	3.973
8	Sadarak	781	7	-	-	709	15	50
9	Upper Karabakh	440.372	80.601	15.138	4.177	82.013	3.042	225.401
Total:		**1.153.899**	**169.363**	**36.529**	**18.136**	**318.348**	**7.412**	**576.001**



Fig. 5. The situation of the villages before occupation and the current appearance of villages

The results of large-scale soil studies carried out by other researchers show that in the mountainous part of the Karabakh region, were found mountain-meadow primitive, mountain-meadow soddy, mountain-forest meadow, mountain-meadow dark, mountain-meadow black, mountain-forest brown typical, mountain-forest brown carbonate, mountain-forest brown typical, mountain-meadow steppe, mountain-forest brown cultivated, gray-brown mountain dark, mountain-forest brown leached, mountain-forest brown steppe, mountain-chestnut dark soils, and in the plain part the following types and subtypes: chestnut ordinary, chestnut long-irrigated, meadow-chestnut, gray, dark gray, gray typical, gray irrigated, gray meadow-brown, floodplain-meadow (alluvial-meadow), chestnut dark soils (Mammadov, 2019; Mammadov et al., 2019).

During the occupation, 7 categories of soils that existed in Karabakh were destroyed. The occupiers violated the legal regime and the purpose of the land and used the soil only for agriculture, including for the cultivation of narcotic plants.

As can be seen from the table 2 the quality of soils in the liberated areas is high and they mainly belong to the group of excellent and good quality. Bonitet points are calculated according to the results of grading surveys of cereals, grapes, fruit crops, winter and summer pastures (Fig. 2).

Before the occupation, the area of land categories was as follows:

1. Agricultural soils - 336 742 hectares. The most recent information on these soils (1992) is presented in table 2. The occupiers committed extreme violations on these lands and used them to grow crops, especially narcotic plants. During the occupation period, the main drug trafficking took place on the territory of Karabakh. Due to this, 30% of the grain needs of the Armenian Republic were satisfied (Fig. 2 and 6).

Currently, large-scale land management plans are being prepared, the boundaries of natural and economic zones are being clarified.



Fig. 6. Soils out of agricultural turnover

2. The lands of settlements are only 5 592 hectares, of which 1709 hectares are occupied by residential buildings of townspeople, and 3668 hectares - land for state development. The entire housing stock in cities, towns and villages was destroyed. All houses, schools, hospitals, factories were demolished, and useful building materials were taken to Armenia (Fig. 5).

During the recovery period, it is planned to renew all settlements and provide the population with comfortable housing, reconstruct the old infrastructure. For the first time, smart cities and villages will be created in these regions of Azerbaijan. In the category of land of settlements, it is necessary to take into account projects of reconstructed settlements, the laying of road transport lines and telecommunications.

3. The regime for the use of **industrial, transport, communications**, defense and other categories of land was not respected. The entire transport and communication system was destroyed.

On behalf of the head of government, the restoration of infrastructure has begun here. For example, the construction of Tartar-Sugovushan, Fizuli-Shusha roads, the construction of an airport in Fizuli and the construction of an airport in Kalbajar in the future. All these works should be taken into account when determining the boundaries of this category of land.

4. The soils of the specially protected areas are 43947 hectares. Garagol State Natural Reserve (240.0 hectares), created on the territory of Lachin region, acted in the direction of protecting rare species of fauna. Rare breeds of animals such as brown bears, wolves, roe deer, wild boars, jackals, badgers and mountain goats were protected here. On the territory of the Zangilan region - the state reserve Basitchay (107.0 hectares), Lachin (21400.0 hectares), Gubadli (20,000.0 hectares) and Arazboyu (2200.0 hectares) reserves, where oak, maple, hawthorn, wild rose, juniper, sycamore, poplar, as well as trees and shrubs listed in the Red Book, which are rare specimens of flora. In these territories, the protection of plane trees with a diameter of one meter, a height of 30 m and over 300 years old and rare vegetation of Tugay forests is organized.

5. Forest fund - 246187 hectares. The forests were also subjected to Armenian vandalism. On the other hand, these forests were cut down for fuel and large open fields were formed. These fields were mainly used for the cultivation of narcotic plants.

As a result of cutting down about 25-30% (54 thousand hectares) of forests and exporting them to Armenia as building materials, processes of severe water and wind erosion occurred on forest soils.

Table 3. Ecological parameters of territory.

Soils	ECOLOGICAL PARAMETERS OF SOIL																						
	H	P	∑T	BİP	MD	HUMUS	pH	waq	GR					E				s				Point	Farm location
									g	h.c	m.c	l.c	q	e	l.e	m.e	h.e	s	l.s	m.s	h.s		
Mountain-meadow	2000	1200-1400	1000-2000	1.60	0.60	6.4	4.3-6.3	78	-	-	-	-	-	1.0	0.8	0.6	0.3	-	-	-	-	89	Summer pastures
Brown mountains and forests	800-1200	800-900	2500-3000	1.50-1.90	0.45-0.60	2.9	5.1-7.2	76	0.8	0.9	1.0	0.89	0.6	1.0	0.8	0.5	0.2	-	-	-	-	87	Forest (Hornbeam, beech)
Brown mountain-forest	2000-1200	550-700	3000-4200	1.80-2.30	0.25-0.45	3.0	7.0-7.5	78	0.8	0.9	1.0	0.89	0.6	1.0	0.7	0.5	0.2	-	-	-	-	85	Forest (Oak)
The mountain is black	500-1600	500-1600	3800-4500	2.10-2.70	0.28-0.30	3.9	7.0-7.5	70	0.8	0.9	1.0	0.89	0.6	1.0	0.9	0.5	0.3	-	-	-	-	100	Cereals, Potatoes
Chestnut	300-500	300-450	3800-4400	1.80-2.20	0.20-0.25	3.0	7.5-8.2	48	0.8	0.9	1.0	0.89	-	1.0	0.6	0.4	0.2	1.0	0.91	0.64	0.56	60	Grapes, grains, Winter Pasture
Gray-brown	200-550	400-500	3800-4400	1.70-2.20	0.20-0.25	2.8	7.5-8.2	71	0.8	0.9	1.0	0.89	-	1.0	0.7	0.5	0.3	1.0	0.91	0.64	0.56	63	Grapes, grains, Pomegranate, Winter Pasture
Gray	Up to 150	200	4200-5600	0.8-1.80	0.10-0.15	1.6	8.4-8.9	26	0.78	0.6	1.0	0.73	-	1.0	0.6	0.4	0.2	1.0	0.73	0.63	0.42	66	Grain, Cotton, Winter Pasture
Gray-brown	Up to 100	350	4600	0.8	0.10-0.15	1.0	8.7-9.0	22	0.78	0.6	1.0	0.73	-	1.0	0.7	0.4	0.3	1.0	0.73	0.63	0.42	42	Pomegranate, Olive, Grapes,
Meadow	100	250	4400	0.8-2.0	0.10-0.15	1.7	7.4-8.6	40	0.36	0.91	1.0	0.89	0.6	1.0	-	-	-	1.0	0.86	0.60	0.55	63	Cotton, Winter Meadow
Pebble river beds	It stretches from the Alpine zone to the lowlands along the mountain river beds																						
Bare rocks saline clay rocks	Geological derivatives																						

Table 4. Agroclimatic features of the liberated territories

Agroclimatic features / Soil types and subtypes	Average annual air temperatures	Average annual minimum absolute temperatures in	Average annual minimum air temperature	Average annual maximum absolute temperature	Average annual soil temperature	Amount of temperature above 10 degrees	Average annual relative humidity, %	Annual amount of precipitation, mm	Annual possible evaporation, mm	The amount of annual snow-covered days	The number of days with annual hail
Mountain meadow primitive	10,0	-14	-21	36	12	3086	65	641	780	49	3,3
Mountain meadow soddy	10,0	-14	-21	36	12	3086	65	641	780	49	3,3
Mountain forest meadow	10,0	-14	-21	36	12	3086	65	641	780	49	3,3
Mountain meadow black	7,4	-18	-25	34	10	2263	72	696	376	65	6,8
Mountain meadow black	7,4	-18	-25	34	10	2263	72	696	376	65	6,8
Mountain meadow dark	7,4	-18	-25	34	10	2263	72	696	376	65	6,8
Mountain forest brown leached	7,4	-18	-25	34	10	2263	72	696	376	65	6,8
Mountain-forest brown steppe	8,4	-14	-22	32	10	2591	72	711	597	54	4,2
Mountain forest brown typical	8,4	-14	-22	32	10	2591	72	711	597	54	4,2
Mountain forest chestnut typical	8,4	-14	-22	32	10	2591	72	711	597	54	4,2
Mountain forest brown cultivated	8,4	-14	-22	32	10	2591	72	711	597	54	4,2
Mountain meadow steppe	10,9	-12	-20	37	13	3408	69	587	751	31	4,1
Mountain forest brown carbonate	10,9	-12	-20	37	13	3408	69	587	751	31	4,1
Mountain-forest brown steppe	10,9	-12	-20	37	13	3408	69	587	751	31	4,1
Mountain forest brown loess	10,9	-12	-20	37	13	3408	69	587	751	31	4,1
Mountain gray-brown dark	13,2	-11	-18	39	-	4168	66	486	920	18	0,8
Mountain gray-brown ordinary	13,2	-11	-18	39	-	4168	66	486	920	18	0,8
Chestnut ordinary	13,2	-11	-18	39	-	4168	66	486	920	18	0,8
Chestnut long-irrigated	13,1	-10	-17	40	16	4116	69	458	848	13	1,4
Meadow chestnut	13,1	-10	-17	40	16	4116	69	458	848	13	1,4
Gray typical	13,1	-10	-17	40	16	4116	69	458	848	13	1,4
Gray irrigated	13,1	-10	-17	40	16	4116	69	458	848	13	1,4
Gray meadow	13,3	-13	-21	41	17	4246	66	467	966	25	1,0
Floodplain meadow (alluvial meadow)	13,3	-13	-21	41	17	4246	66	467	966	25	1,0
Chestnut dark	13,3	-13	-21	41	17	4246	66	467	966	25	1,0

For the production of parquet, especially relict rare tree species were deliberately cut down. As a result, the soils became steppe. It will take decades to plant and grow forest trees in these areas.

6. The total land area of the **water fund** was 19,800 hectares. Reservoirs and hydroelectric power stations of Sarsang and Sugovushan are of great importance here. The water fund also includes parts of the Bargushag, Khakari, Tartar, Araz rivers, as well as other small rivers and lakes. For a long time, the Armenian occupiers did not allow the use of these reservoirs, and therefore there was a constant shortage of water in the adjacent areas.

7. The area of land of the **reserve fund** previously amounted to 3083 hectares. However, the area of these lands has increased significantly due to various defensive structures, fortifications, trenches, built by the Armenians on suitable lands during the occupation. On these soils, it is necessary to carry out reclamation studies to determine the area. Then it is necessary to take measures to return these soils to agricultural use. In parallel with this, large-scale studies of soils on the lands of the reserve fund should be carried out and the fertility of the territory should be assessed (Fig. 6).

First of all, it is necessary to restore the legal regime, to clarify the areas and boundaries of land categories. At the same time, the new reconstructed infrastructure should be taken into account in the master plans that will be developed for the restoration of urban and rural settlements. Large-scale

land-use plans should be developed for each administrative region and municipality. To ensure the implementation of all these works, it is necessary to immediately start land surveying work, determine the area of soil categories, target purposes and conduct land surveying field work in order to clarify the boundaries.

Changes in the region's soils with the involvement of the region's lands in large-scale soil research, changes caused by anthropogenic impacts (wind and water erosion, technogenic disturbances, desertification) require scientific study. The reasons for the decline in fertility should be scientifically investigated, as well as proposals and recommendations for their restoration should be given.

Soil research will study the supply of nutrients to the soil, structure, granulometric composition and the intensity of erosion processes. These metrics are used as the basis for calculating grade scores. As part of the agroecological assessment, agroecological maps will be prepared with the study of more than 50 elements of soil, climate and relief.

Should be prepared new soil maps and quality maps of administrative-territorial districts and municipalities at the scale of 1:10000 (1:25.000 in mountainous areas).

The staff of the Institute of Soil Science and Agrochemistry of ANAS bears great responsibility for the implementation of this work. The Institute has already begun work in this direction. For this, a special laboratory has been created to conduct large-scale soil and agroecological research. All studies and cartography use modern GIS technologies. To organize the work and monitor the processes, it is planned to open a strong point of the institute in the Karabakh region.

One of the main tasks is to implement land reform in the region. Preliminary work has begun at the Institute of Soil Science and Agrochemistry to calculate land shares in points per hectare, and currently work is underway to calculate quality points for each region of the region and quality cartogram.

During the land reform, the list of people who will receive land shares and privileges should be clarified and land resources should be distributed according to forms of ownership. Once the land norms are known, the process of measuring and transferring the lands to the owners will begin. It seems to us that the experience of the Russian Federation can be used in this process. That is, in the process of settlement, as the population settles, the lands must be measured and given. It would be more appropriate to give land shares to citizens born after August 2, 1996, after they come to live permanently in Karabakh. This will be the best campaign for the population to return to their former place of residence.

Most of the soil is suitable for agriculture. Before the occupation, there were 187 thousand hectares of arable land, 46 thousand hectares of perennial crops, 18 thousand hectares of hayfields and 337 thousand hectares of pastures. The soils are especially fertile in the Arazboyu strip, Aghdam, Fizuli, Jabrail and Gubadli regions. During the occupation, as a result of the construction of fortifications, digging trenches, trenches and other defense facilities in these areas, the lands were destroyed and degraded to varying degrees. One of the important issues is to conduct reclamation research on these lands and then implement scientific and practical measures to return the lands to cultivation. This deplorable landscape is present throughout the region.

As a result of large-scale soil research conducted by the Institute of Soil Science and Agrochemistry in the pre-occupation years, quantitative assessment of soil fertility was carried out for all regions of the region and land maps and quality cartograms were compiled, agro-industrial grouping of lands was carried out.

Most of the soil in the region belong to quality groups I, II and III. Fertility was estimated at 54-100 points.

30-40 years have passed since the assessment of these soils, and as a result of the destruction of flora and fauna, strong soil degradation processes (erosion, salinization, desertification, wind and water erosion) have occurred in many places. With regard to soil fertility and structure, there have been profound and negative changes in the amount of nutrients it contains.

The agroclimatic features of the liberated territories show that various trees and shrubs can be grown here, as well as agricultural and livestock soils can be developed. The average annual temperature, rainfall, effective temperature, relative humidity and other climatic elements, as well as the restoration of irrigation systems in Aghdam,

Fizuli, Zangilan, Jabrail districts create all conditions for planting millet, peas, lentils, beans, etc., orchards (apples, pears, quince, pomegranates, dates, cherries, plums) and grape plantations, planting mulberry seedlings for the development of cocoons. In addition, in the foothills and plains there is an opportunity to grow industrial crops (cotton, corn, sunflower, soybeans, etc.). In these areas, it is possible to grow and obtain high yields from the kiwi, which is a subtropical plant. The use of waters from the Araz, Khakari and Bargushad rivers, the Sarhang and Sugovushan reservoirs will ensure high yields. There are good conditions for gardening and planting potatoes in the high and middle mountainous parts of the Kalbajar, Shusha and Gubadli regions. Soils in the lower parts of these regions can be used for agricultural purposes (Table 4).

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Azərbaycanın işğaldan azad olunmuş ərazilərinin torpaq və ekoloji qiymət xəritələrinin tərtibi

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Məqalədə Qarabağ bölgəsində yayılmış torpaqların ümumi keyfiyyət göstəriciləri təsvir edilmişdir. İşğaldan azad olunmuş torpaqların əvvəlki və sonrakı vəziyyəti müqayisəli şəkildə öyrənilmişdir. Bölgənin torpaqlarının gələcəkdə daha səmərəli istifadəsi üçün aqroekoloji xüsusiyyətləri araşdırılmış və təkliflər irəli sürülmüşdür. Azərbaycanın, o cümlədən işğaldan azad olunmuş torpaqların aqroekoloji rayonlaşdırılması, Coğrafi İnformasiya Sistemləri vasitəsilə ekoloji qiymətləndirilməsi aparılmışdır. Həmçinin Kiçik Qafqazın hündürlük modeli, torpaq, bonitirovka, ekoloji qiymət xəritələri hazırlanmışdır. Ümumi xəritələrdən başqa hər bir rayon üçün də bu xəritələr tərtib edilmişdir.

Açar sözlər: *Qarabağ bölgəsi, ekoloji qiymətləndirmə, aqroekoloji xüsusiyyətlər, kənd təsərrüfatı, torpaq xəritəsi, CİS*

Составление почвенных карт и карт экологической оценки почв территорий Азербайджана освобожденных от оккупации

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В статье представлены данные качества почв, распространенных в Карабахском регионе. Проведено сравнительное изучение состояния почв до и после оккупации. Изучены агроэкологические особенности почв региона и даны предложения по дальнейшему и более эффективному использованию их в будущем. Агроэкологическое районирование и экологическая оценка проводились на основе географических информационных систем. Также подготовлены высотная модель Малого Кавказа, карты почв, бонитировки и экологического оценивания. Помимо общих карт, были составлены соответствующие карты для каждого района.

Ключевые слова: *Карабахский регион, экологическая оценка, агроэкологические особенности, сельское хозяйство, карта почв, ГИС*

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